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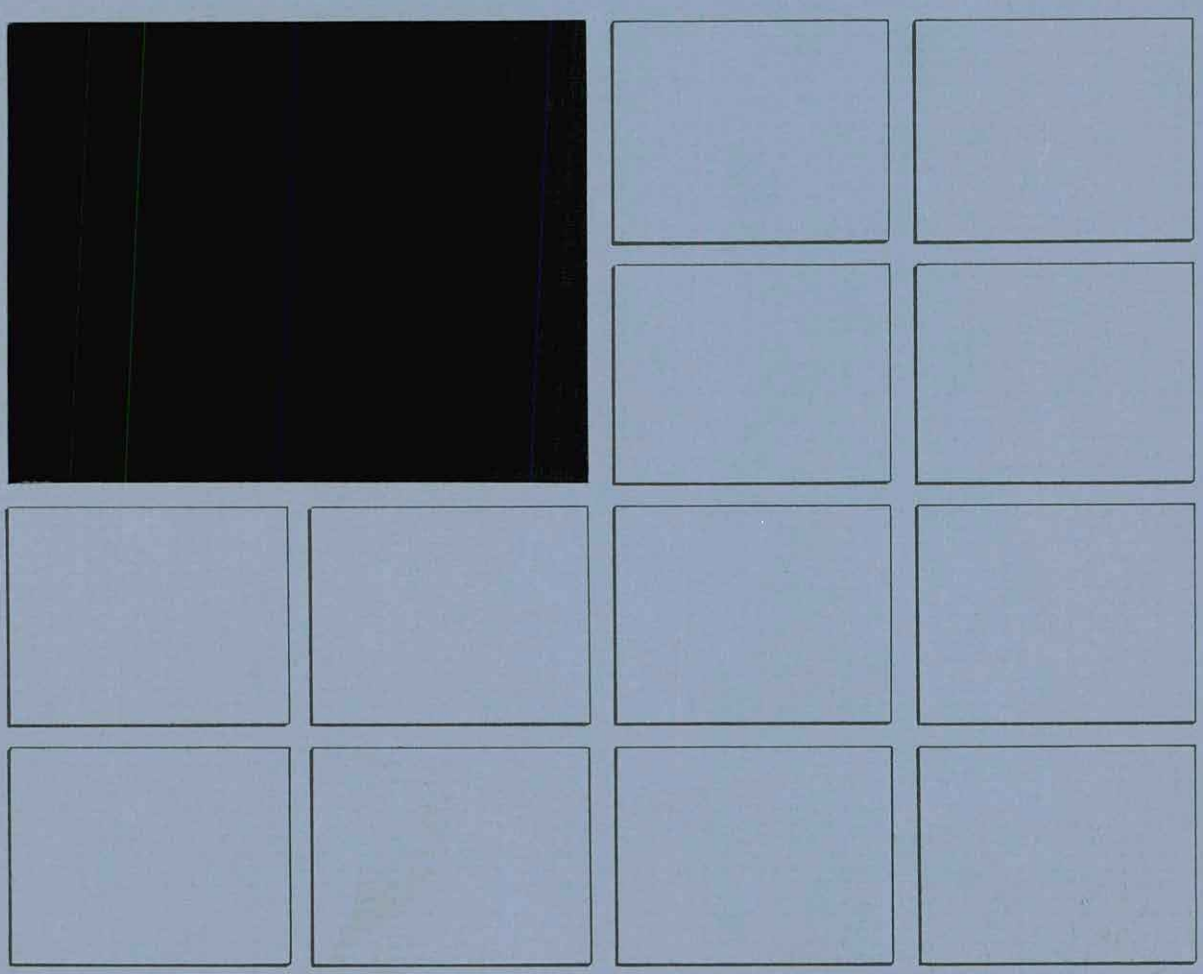

Federal Capital City
NIGERIA
Phase 1 Area
Flood Estimates

FEDERAL CAPITAL CITY
NIGERIA
PHASE 1 AREA FLOOD ESTIMATES

May 1980

This report is prepared for
Milton Keynes Development Corporation

by

Institute of Hydrology
Wallingford
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FEDERAL CAPITAL CITY NIGERIA - PHASE 1 AREA FLOOD ESTIMATES

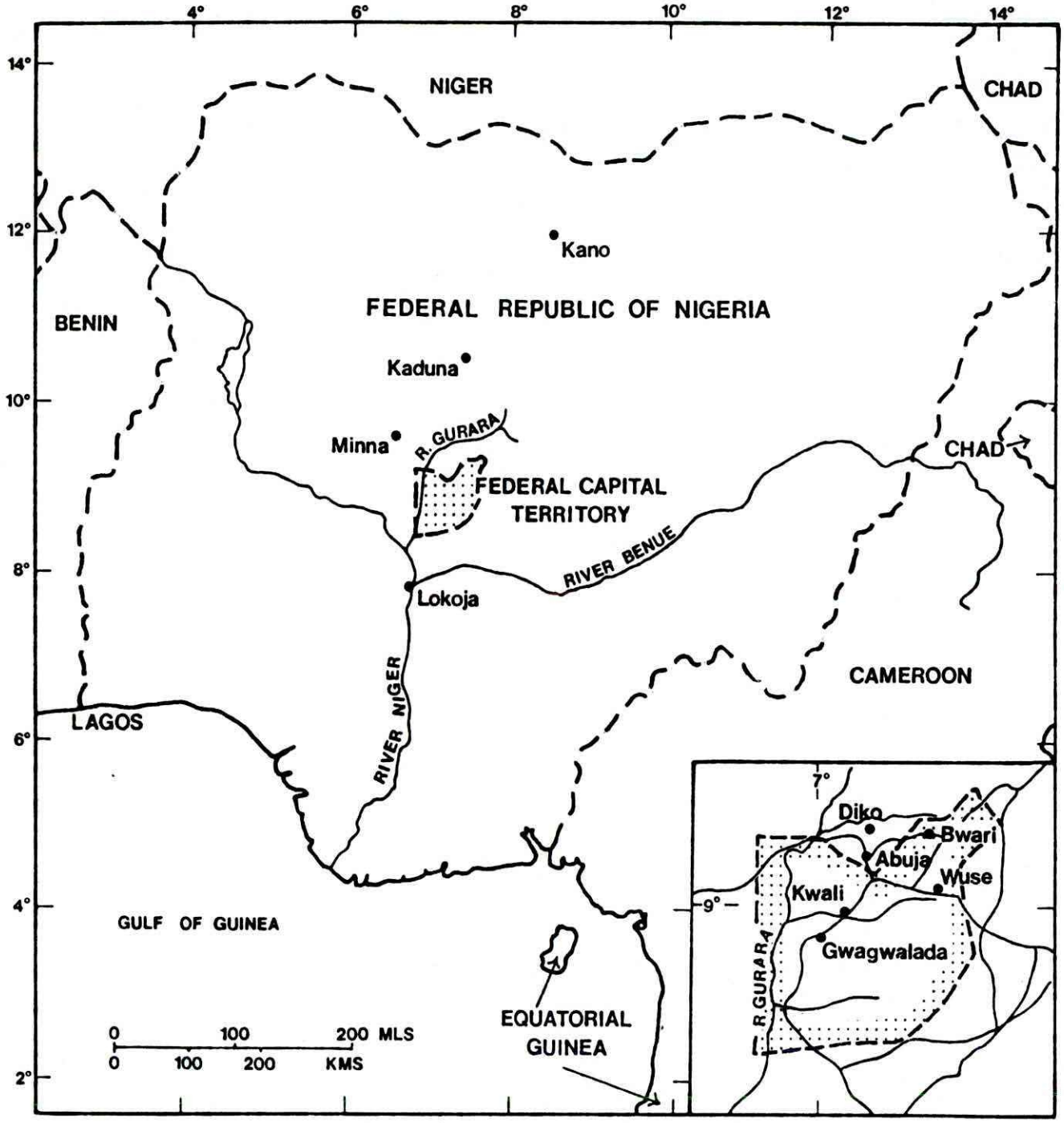
Introduction

This report provides estimates of the 25 and 100 year return period floods for the Phase 1 area of the new Nigerian Capital City located in Federal Capital Territory (Figure 1). The catchment under study comprises three main rivers; River 1 (River Ndawuse), River 2 and River 3. These are shown in Figure 2 and have a total catchment area of 103.6 sq km. Subcatchments and their boundaries marked on Figure 2 indicate 13 points on the river system where flood estimates have been provided and these correspond to similar points on the 1:10,000 map supplied by the client (Ref 5). Three additional points have been added where it appeared logical to produce flood estimates. Table 1 shows the correspondence between the two sets of annotation. The urban area shown in Figure 2 was defined by the peripheral roads on the 1:10,000 map.

To our knowledge there are no rainfall records from within the area and there have only been a limited number (6) of river gaugings at point 1C. In the absence of such data it has been necessary to make several important assumptions (eg percentage runoff, rainfall profile) in order to estimate the design flood hydrographs. These assumptions tend to be conservative and could be reviewed when more data become available.

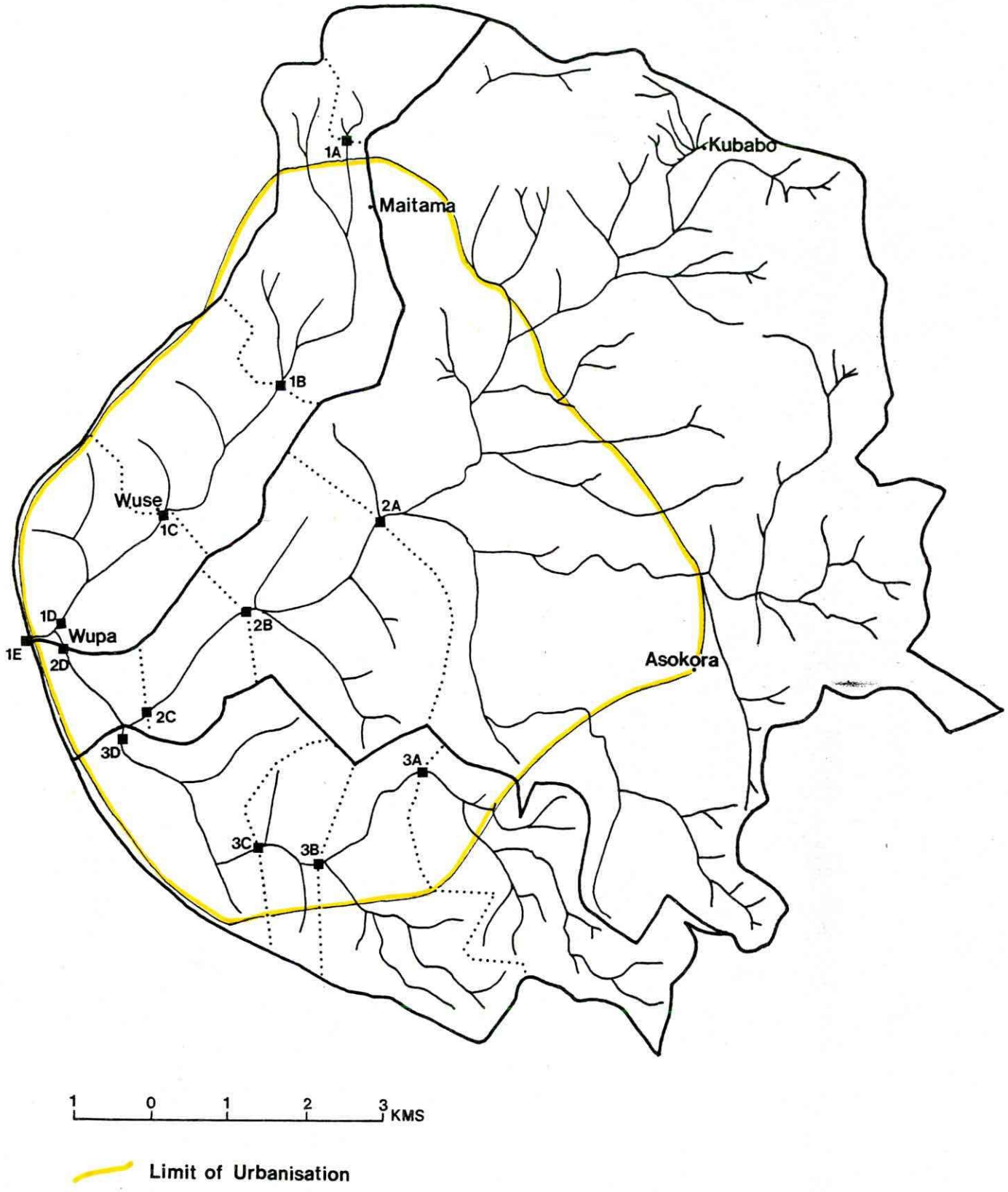
To assist the client with assessing the effect of urbanising the catchment, additional flood estimates have been provided for all sites assuming a natural (rural) catchment. If these estimates, which relate to the present state of the catchment, can be seen to be reasonable by those with a local knowledge of the river system, then this should provide additional confidence in the validity of the urbanised catchment floods. A total of 52 design flood hydrographs have therefore been synthesised (13 sites, 2 return periods, 2 conditions).

We believe that the most satisfactory method of producing flood estimates on these catchments is by the combined use of a unit hydrograph to determine the nature of catchment response and rainfall intensity/duration/



LOCATION OF FEDERAL CAPITAL TERRITORY

Figure 1



PHASE 1 CATCHMENT AREAS

Figure 2

TABLE 1

Subcatchment notation

	Figure 2 notation	1:10,000 map notation	
River 1	1A	additional point	
	1B	7	
	1C	6	
	1D	additional point	
	1E	5	(incorporating Rivers 2 and 3)
River 2	2A	3	
	2B	2	
	2C	1	
	2D	4	(incorporating River 3)
River 3	3A	F	
	3B	D	
	3C	B	
	3D	additional point	

frequency relationships to produce rainstorms of the desired severity. Although this study has made extensive use of the methods of analysis described in the Flood Studies Report (FSR) (Ref 1), whenever possible local data have been used to modify relationships from United Kingdom catchments.

The present report contains a brief description of the unit hydrograph method, a survey of the available data, and a detailed exposition of how the method was applied to the data to give the required estimates. The recommended design peak flows are summarized in Table 3 of this report. Complete hydrograph predictions are given in the Appendices.

The unit hydrograph method

The unit hydrograph for a particular catchment defines the response to a unit volume of net or effective rainfall input over a specified time interval. In common with FSR practice a unit input of 10 mm net rainfall has been used throughout this report. The unit hydrograph method relys on two main assumptions of catchment behaviour.

1. There is a linear relationship between net rainfall and flood discharge; ie twice the rain doubles the flow.

2. The principle of superposition applies. The final flood hydrograph may therefore be considered to comprise the direct addition of the ordinates of a series of unit hydrographs scaled and lagged according to the net rainfall hyetograph. This process is called convolution.

Flood estimation using the FSR unit hydrograph technique may be summarised as follows:-

1. Estimating the shape of the unit hydrograph. The unit hydrograph is most reliably obtained from an analysis of recorded flood and rainfall data from the catchment itself. This process also yields the percentage runoff, ie the proportion of rain effective in

producing the flood hydrograph. It is recommended (Ref 1, I.6.8.4)* that at least five large events should be used in the analysis. However, in the absence of this data a synthetic unit hydrograph may be derived from catchment characteristics such as stream length and slope using a regression equation derived from gauged catchments elsewhere. The FSR provides such equations based on the analysis of nearly 140 catchments and 1400 flood events in the United Kingdom. These equations have successfully been applied to many catchments worldwide. The United Kingdom percentage runoff equation cannot so easily be transferred (see (3) below).

2. Defining a suitable design storm. A rainstorm of the required severity is constructed from local records of rainfall and an assumed rainfall profile. For application outside the United Kingdom, rainfall intensity/duration/frequency graphs are commonly used for rainstorm synthesis. This process is described later.

3. Estimating the percentage runoff from the design storm. An estimate of the percentage rainfall effective in producing runoff is required. This is most accurately achieved from rainfall and flow records on the catchment itself. However, if not available, an approximation may be made by analogy to similar catchments or by the use of locally derived regression equations based on soil type.

4. Combining the unit hydrograph with the (net) design storm. The net rainfall profile is convoluted with the unit hydrograph to produce the flood hydrograph. To this must be added a slow response or 'baseflow' component of the hydrograph but this is usually small by comparison with the direct runoff from major floods.

Data available

Hydrological information from within the Federal Capital Territory has been collected and analysed for a water resources survey undertaken by

* References to the Flood Studies Report are given by volume (Roman numerals), chapter and section.

H P Gauff GmbH and Co, Adejumo Ogunsola and Partners and Noyuk (Ref 2). This report provides an analysis of rainfall data in the area and in particular an intensity/return period graph for daily rainfall totals from the Diko and Abuja gauges. From the same report it is evident that the River Iku has been gauged at Abuja since 1962; however, these data were not directly available to us. Of the 17 regular gauging stations newly installed in the Federal Capital Territory (Ref 2), one lies within the Phase 1 area at point 1C (Figure 2). The only data available were six river gaugings undertaken in 1978 and reported in the water resources survey (Ref 2).

Meteorological Note No 19 of the Nigerian Meteorological Service (Ref 3) provides rainfall intensity/duration/frequency curves for 21 stations countrywide. It is unfortunate that the only available copy of this Note contains just one curve namely that for Ilorin. However, as will be shown later, it is evident that on a daily basis at least, there is close correspondence with Abuja and Diko data.

The following maps were used to determine catchment characteristics:

1:10,000 map covering most, but not all, of the total catchment
1:50,000 map covering the complete area.

Unit hydrograph estimation

Since there were no continuous flow records and recording rainfall data from the subject catchments, it is necessary to construct a synthetic unit hydrograph based on catchment characteristics. Using the simplest equation from the FSR based on stream length and slope (Ref 1,I.6.5.4) the time to peak of the unit hydrograph (Tp) is defined as:

$$Tp = 2.8\left(\frac{L}{\sqrt{S}}\right)^{0.47} \text{ hours}$$

where L = main stream length measured from a 1:25,000 map using dividers set to 0.1 km spacing (for this study the average stream length from the 1:10,000 and 1:50,000 map was used)

S = slope of the main stream (m/km) measured at 10% and 85% of L from the mouth of the catchment.

A standard triangular shape (Ref 1,I.6.5.2) has been adopted where the time base, TB, and peak discharge, QP, are defined as follows:

$$TB = 2.52\ Tp$$

$$QP = \frac{220}{Tp} \text{ cumecs/100 sq km}$$

These relationships were derived from about 140 catchments in the UK. There is almost identical agreement with a similarly simplified triangular unit hydrograph derived from American data by the US Soil Conservation Service.

Throughout this report a time interval of 0.25 hours has been used in producing flood estimates. Because of the range of size of catchments under study (2.3 km^2 to 103.6 km^2) a smaller time interval would normally be recommended for the smaller catchments and a bigger time interval for the larger catchments. However, to maintain consistency in the analysis a 0.25 hour time base was considered optimum. The above equation defining Tp was derived using a standard 1 hour time interval. The FSR (Ref 1, I.6.4.8) recommends the following adjustment to Tp:

$$\text{new Tp} = \text{old Tp} + (T-1)/2$$

where T = new basic time interval = 0.25 hours, therefore

$$\text{new Tp} = \text{old Tp} - 0.375$$

Times to peak for each of the 13 catchments have been calculated and are given in Table 2. It should be noted that these values of Tp correspond to the purely rural catchment. Urbanisation can have a dramatic effect on both the magnitude of peak discharge and the rise time. Urban time to peak is computed from the following equation (Ref 4):

TABLE 2

Catchment properties

Catchment	Total Area sq km	Main Stream Length km	Slope S m/km	URBAN	T_{p_r} (rural) hrs	T_{p_a} (urban) hrs	Duration D (rural) hrs	Duration D (urban) hrs	SPR (urban) %
1A	2.32	1.25	74.7	0	0.8	0.8	2.25	2.25	50
1B	7.41	4.55	20.2	.622	2.4	0.7	6.25	2.25	60
1C	12.39	6.75	12.4	.761	3.4	0.9	8.75	2.75	62
1D	16.42	8.75	11.1	.820	4.0	1.0	10.75	2.75	63
1E	103.64	14.9	7.8	.507	5.8	2.3	15.25	6.25	58
2A	57.85	9.5	21.5	.277	3.5	2.0	9.25	5.25	54
2B	64.45	11.6	17.1	.351	4.2	2.1	11.25	5.75	56
2C	66.17	13.3	10.4	.368	5.0	2.5	13.25	6.75	56
2D	87.22	14.9	7.8	.488	5.8	2.6	15.25	6.75	57
3A	6.00	5.05	25.1	.205	2.4	1.6	6.25	4.25	53
3B	10.64	6.7	19.7	.411	3.0	1.3	7.75	3.75	57
3C	12.68	7.45	18.8	.506	3.2	1.2	8.25	3.25	58
3D	19.6	10.4	10.8	.680	4.4	1.3	11.75	3.75	61

$$Tp_u = Tp_r \ (1 + URBAN)^{-1.99}$$

where Tp_u = urban time to peak

Tp_r = rural time to peak

URBAN = fraction of the total catchment under urban development (Figure 2)

Table 2 gives values of URBAN and Tp_u for each catchment. Figure 3 shows the rural and urban unit hydrographs for the total catchment (point 1E, Figure 2).

Design parameters

In order to estimate the 25 year and 100 year return period floods using the unit hydrographs derived above it is necessary to choose the return period of the design storm, storm duration and profile, percentage runoff, baseflow and antecedent conditions for the catchment. These are considered in the following sections.

Rainfall return period

For this study it has been assumed that the storm and flood return period are equal (ie the 25 year return period storm is used to produce the 25 year return period flood). It is appreciated that the response depends on antecedent catchment conditions which vary from event to event and therefore the correspondence is not necessarily exact, but in the absence of local information the assumption is considered reasonable.

Rainfall duration

The FSR (Ref 1, I.6.7.6) recommends the following equation for the duration of the storm:

$$D = Tp \ (1 + SAAR/1000)$$

where SAAR = catchment average annual rainfall

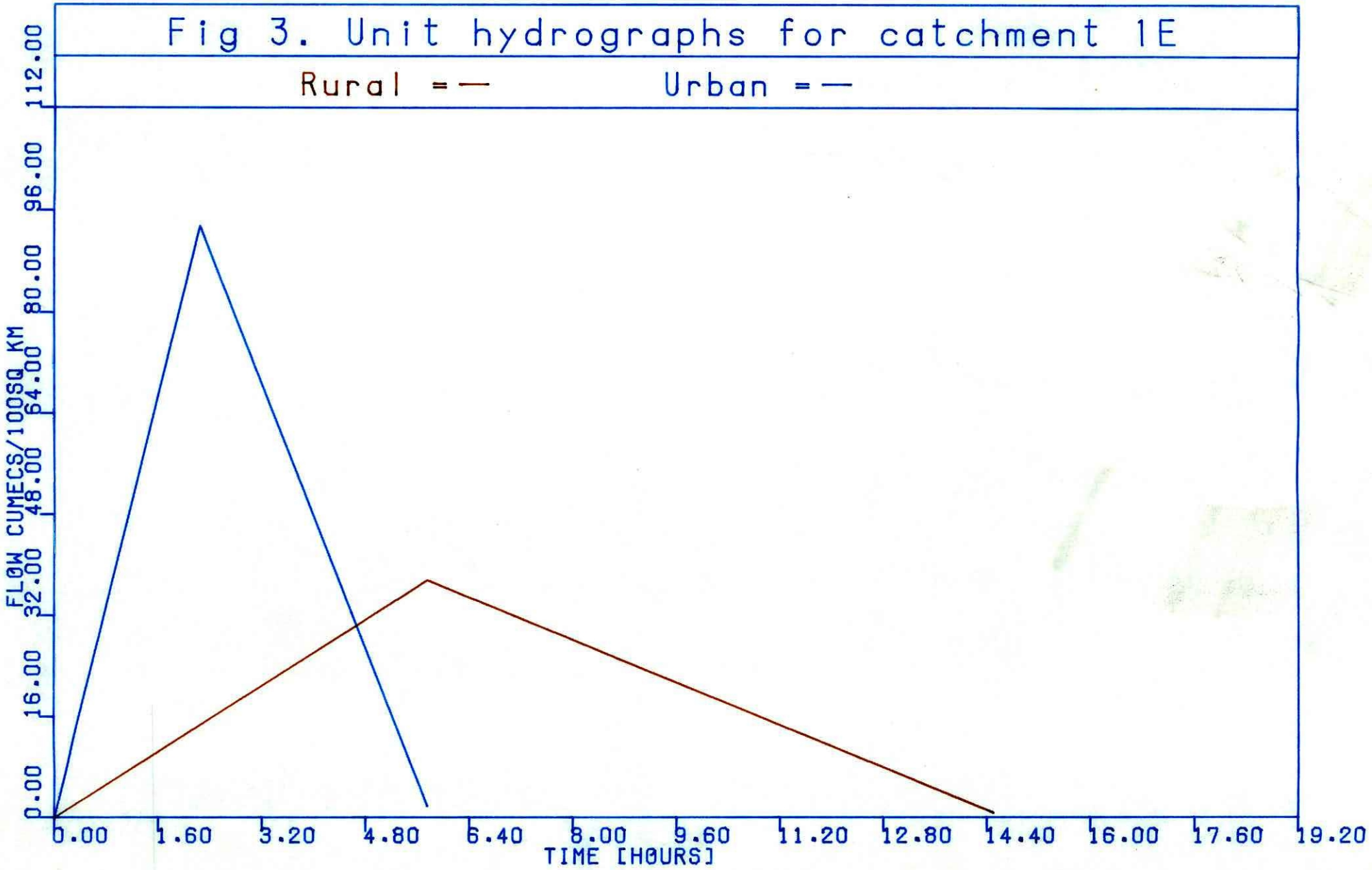


Fig 3. Unit hydrographs for catchment 1E
Rural = —
Urban = —
FLOW CUMECS/100SQ KM
0.00
16.00
32.00
48.00
64.00
80.00
96.00
112.00
0.00
1.60
3.20
4.80
6.40
8.00
9.60
11.20
12.80
14.40
16.00
17.60
19.20
TIME [HOURS]

A common value of SAAR was used for all catchments and derived from the mean annual rainfall for the gauges at Bwari, Abuja and Diko (Figure 1) (Ref 2):

Gauge	No years record	Annual average rainfall (mm)
Bwari	9	1551
Abuja	18	1648
Diko	24	1541

The mean of these three gauges, weighted according to the number of years record from each gave SAAR = 1580 mm.

Using the values of Tp_r and Tp_u previously obtained the duration of each storm was calculated using the above equation. D should, for convenience, be an odd multiple of the data interval. In each case the nearest higher multiple of 0.25 hours has been taken (Table 2). It should be noted that because of the very peaky nature of the rainfall profile (discussed later) the magnitude of the flood peak is relatively insensitive to storm duration since most of the rain falls within the central section.

Rainfall profile

It is necessary to obtain rainfall intensity/duration/frequency curves for the catchments in order that rainfall profiles of the required severity can be developed. For this report the following procedure was adopted to establish these profiles:

1. From the water resources survey (Ref 2, Figure A7) Diko and Abuja records have been combined to give maximum 'daily' rainfalls of different return periods. It is not clear from the text of this report whether the necessary conversion from the daily to 24 hour duration has been carried out. For a given return period, rainfalls over any 24 hour period are higher than those occurring within a calendar day. Since there is no mention of this

conversion in the report it has been assumed here that it has not been carried out. From this graph the following information has been abstracted.

5 year return period daily rainfall = 94 mm
25 year return period daily rainfall = 123 mm
100 year return period daily rainfall = 148 mm

At Abuja therefore the growth factors from 5 year daily rainfall to 25 year and 100 year daily rainfall are 1.31 and 1.57 respectively.

2. From Meteorological Note No 19 (Ref 3) the countrywide conversion factor of daily rainfall values to 24 hour falls is given as 1.132. Hence:

5 year return period Abuja 24 hour rainfall = 94 x 1.132 = 106 mm

3. Meteorological Note No 19 (Ref 3) provides rainfall intensity/duration/frequency curves for 21 stations throughout Nigeria. Unfortunately only one, that for Ilorin, was available for this study. However, there is a close correspondence to the Abuja 24 hour rainfall (5 year return period):

5 year return period Ilorin 24 hour rainfall = 103 mm
5 year return period Abuja 24 hour rainfall = 106 mm

The decision to relate back to the 5 year return period was due to the fact that the Ilorin rainfall intensity/duration/frequency relationship were derived from only 9 years record (Ref 3) and therefore the 5 year return period curve should be more accurate than either those of the 10 year or 25 year return period. Furthermore, the basis of a 5 year return period rainfall statistic is in line with FSR practice (Ref 1).

4. The rainfall intensity/duration curve for the 5 year return period at Abuja was therefore obtained directly from the Ilorin graph after scaling by $\frac{106}{103}$ = 1.03. This curve is shown in Figure 4.

5. The 25 year and 100 year return period curves for Abuja were derived by scaling the 5 year return period relationship according to the 24 hour growth factors (1.31 and 1.57 respectively). There is strong evidence for a constant growth factor (ie irrespective of rainfall duration). The Ilorin graph itself exhibits this property and it is also in line with work carried out in south west Nigeria by the Meteorological Office (UK). The 25 year and 100 year return period curves are shown in Figure 4.

Having obtained Abuja rainfall intensity/duration/frequency curves they were then used to construct 1 in 25 year and 1 in 100 year storms for each of the catchments. A nested profile was adopted such that for all durations the rainfall intensities of the same return period occurred within the same storm. The 1 in 25 year storm of 2.25 hour duration was therefore composed of the 1 in 25 year 0.25 hour fall in the centre of the 1 in 25 year 0.75 hour fall etc. Although the average intensity over the total storm duration has the required return period, nesting the profile in this way tends to create a larger flood because of its peaky nature. However, it is preferable to use local rainfall data in this conservative fashion rather than to adopt the particular (and less peaky) rainfall profile as recommended in the FSR which has validity only in the United Kingdom.

Areal reduction factor (ARF)

Storm profiles so far derived apply to point rainfalls at Abuja. It has been assumed that these point storms are directly transferable to the catchment area. However, areal reduction factors must be applied to account for the fact that point intensities are higher than those occurring, with the same probability of exceedance, over larger areas. From work carried out by the Meteorological Office (UK) in south west Nigeria, areal reduction factors were derived from catchments between 20 sq km and 10,000 sq km and durations of 10 to 500 hours. These were lower by a factor of 0.9 than their FSR United Kingdom counterparts (Ref 1, I.5). For this study where durations and catchment areas less than this are encountered, the same factor has been assumed to apply in this range also, thus enabling the ARF to be calculated for all catchments and all storms.

Since each storm comprises a series of nested storms of different

SYNTHESISED ABUJA RAINFALL INTENSITY/DURATION/FREQUENCY CURVES

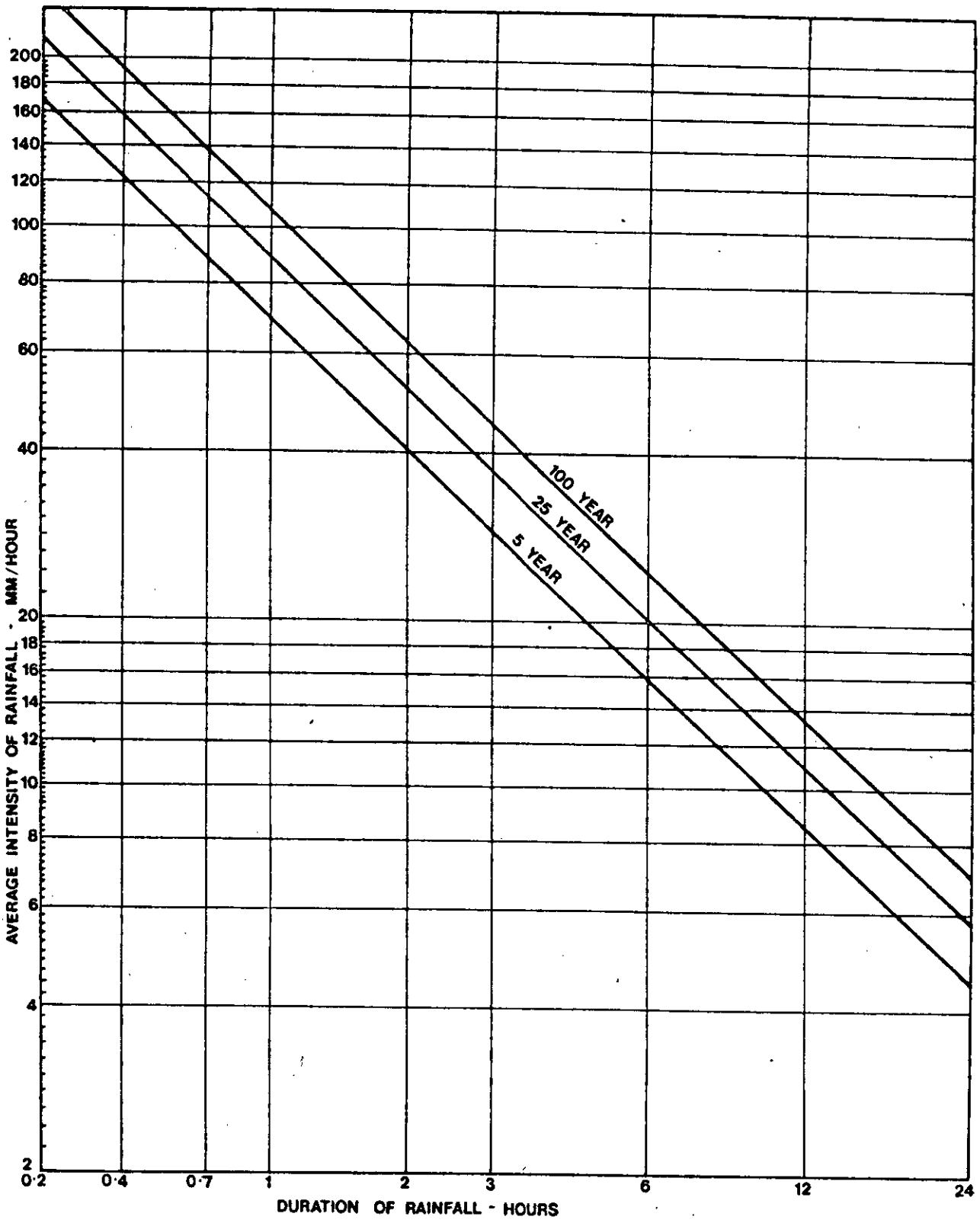


Figure 4

durations, it is logical to apply the appropriate areal reduction factor corresponding to the duration of each 'sub' storm. The central, most intense, 0.25 hour block of rainfall therefore has the highest reduction applied whereas the entire storm has a much lower overall reduction.

The 1 in 25 year and 1 in 100 year areal storm profiles for catchment 1E (Urban) are shown in Figure 5.

Catchment wetness index (CWI)

The CWI is an indication of how 'wet' the catchment is likely to be preceeding the flood event. This index is a combination of the soil moisture deficit (SMD) and a 5 day antecedent precipitation index (API5) and is defined by the FSR (Ref 1, I.6.4.4) such that

$$CWI = 125 - SMD + API5$$

The constant 125 is added simply to maintain positive CWI since in the United Kingdom SMD rarely exceeds 125. In the absence of information to the contrary, it has been assumed that there is no soil moisture deficit (a reasonable assumption during the wet season) which reduces the above equation to:

$$CWI = 125 + API5$$

The FSR (Ref 1, I.6.4.4) defines API5 as

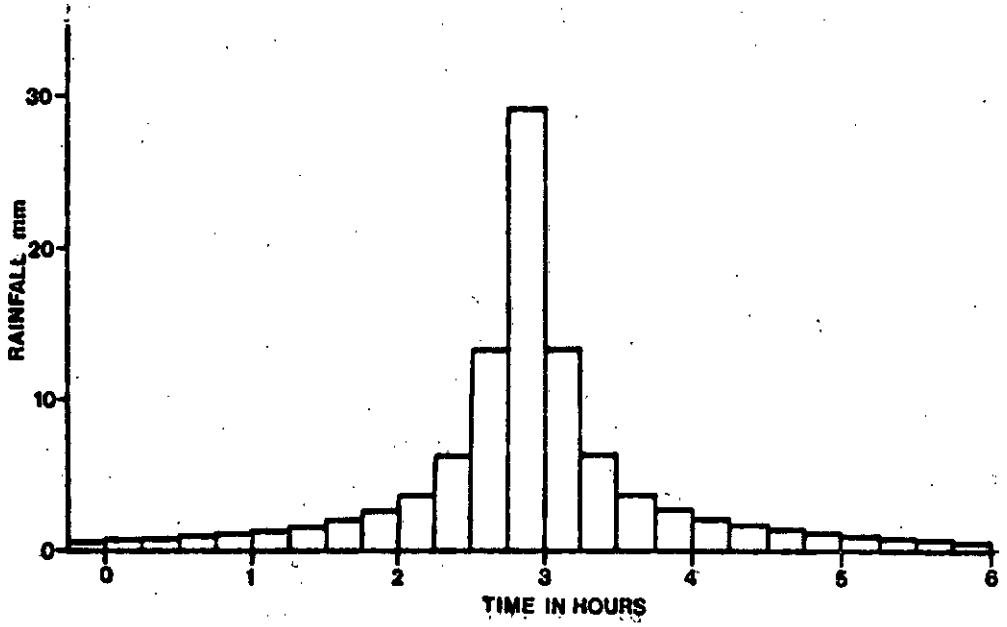
$$API5_d = 0.5^{\frac{1}{2}}(P_{d-1}+0.5P_{d-2}+(0.5)^2P_{d-3}+(0.5)^3P_{d-4}+(0.5)^4P_{d-5})$$

The five days preceding rainfall (P_{d-1},P_{d-2} etc) for the 25 year and 100 year return period floods were estimated from the rainfall intensity/ duration/frequency graph for Abuja (Figure 4) by extrapolation. The following values of API5 and hence CWI were obtained:

	1 in 25 year	1 in 100 year
API5	13.4	16
CWI	138.4	141

DESIGN RAINFALL FOR CATCHMENT 1E

(1) 25 Year Return Period



(2) 100 Year Return Period

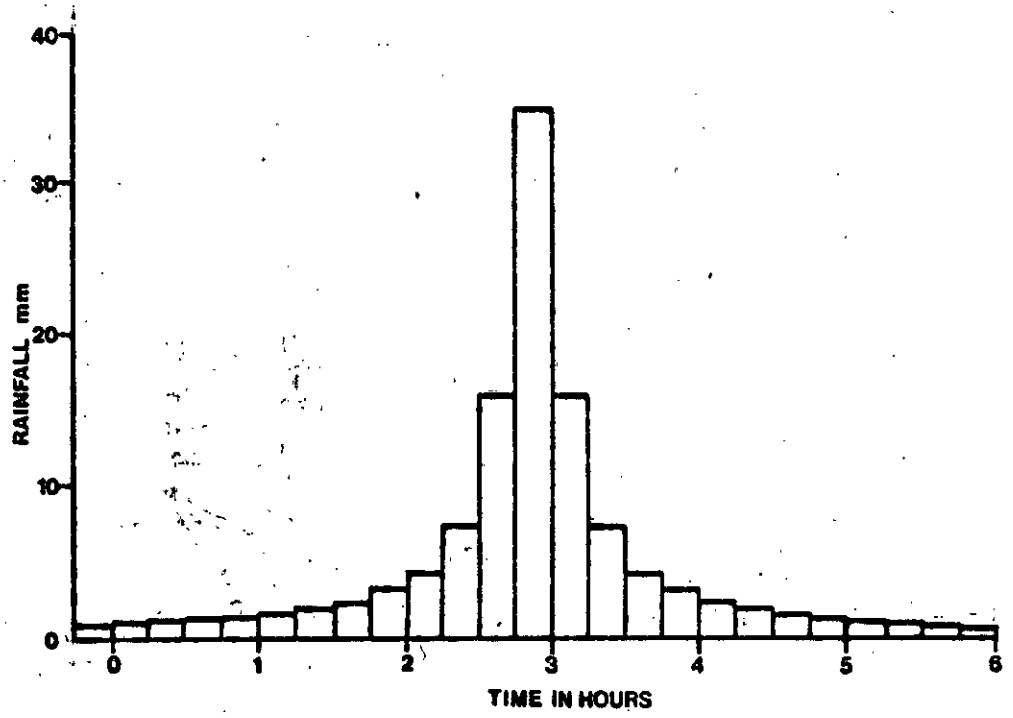


Figure 5

Percentage runoff

There are few available data on which to base an entirely objective assessment of how much of the gross rainfall would be effective in producing flood runoff.

In the water resources survey (Ref 2) it is shown that monthly runoff can be up to half monthly rainfall. Relating this to our experience in comparing flood hydrograph runoff with monthly and seasonal runoff in other parts of Nigeria, it is clear that the land type involved in the subject area is capable of producing relatively high values of percentage runoff. This judgement was aided by advice from the Land Resources Division of the Overseas Development Agency who have mapped soils in this area. In subsequent calculations a 50% standard percentage runoff (SPR) has been used which is increased by the degree of urbanisation. When more data become available from the gauging network in the Federal Capital Territory it would be reasonable to revise this estimate.

The increase in SPR due to urbanisation has been estimated from information about impermeable area on the 1:10,000 map (Ref 5). From this map an average impermeability factor of 0.4 was computed from the 79 land blocks detailed thereon. This factor was subsequently applied to the whole urban area where it was assumed that 90% runoff would occur from the effective impermeable surfaces. The non impermeable area within the urbanised catchment (ie 0.6 of the total urban area) was assumed to have the same standard percentage runoff as the rural catchments (50%).

The equation given below incorporates all the above information:

$$SPR = 50 + 16\ URBAN$$

Using this equation values of SPR were calculated for all catchments and are given in Table 2.

The effects of total storm rainfall (P) and antecedent state of the catchment, as indexed by CWI, are then added to the percentage runoff

for each flood event. Percentage runoff (PR) is defined (Ref 1, I.6.5.8) as:

$$PR = SPR + 0.22\ (CWI - 125) + 0.1\ (P - 10)$$

Using the values of SPR and CWI from above and the total storm rainfall, P, the percentage runoff for each flood was then determined.

Baseflow

The convolution of the unit hydrograph with net rainfall gives the rapid response component of the total hydrograph. To this must be added a slow response or baseflow component of the hydrograph. Baseflow is only a small proportion of the flood hydrograph and its value is therefore not critical to the estimate. The FSR provides an equation for the calculation of baseflow (Ref 1, I.6.5.11).

$$BASEFLOW = AREA\ (0.000326(CWI-125)+0.00074RSMD+0.003)$$

RSMD is defined as the net 1 day rainfall of the 5 year return period and was obtained from Figure 4. Following work done in south west Nigeria the RSMD term was modified to 0.00037 RSMD and it is this form of the equation which was used in this study. For catchment 1C the baseflow is calculated as 0.46 cumecs for the 1 in 25 year flood and 0.47 cumecs for the 1 in 100 year flood.

The water resources survey (Ref 2) gives six gaugings at point 1C (Figure 1) of which three came from the wet season (September and October 1978) giving values of 0.202, 0.32 and 0.41 cumecs. If it is assumed that these gaugings were not carried out during a flood event they tend to confirm that the above equation (modified) is giving baseflow estimates of the right order.

Flood estimate results

The design rainstorms discussed above were multiplied by the appropriate percentage runoff (which ranged from 61% to 77%) and convoluted with the unit

hydrograph from each catchment. To this the baseflow was added to give the 1 in 25 year and 1 in 100 year flood estimates for both the rural and urban catchments.

Details of these results may be found in the appendices:

Appendix A - 25 year return period urban catchment floods
Appendix B - 100 year return period urban catchment floods
Appendix C - 25 year return period rural catchment floods
Appendix D - 100 year return period rural catchment floods

Peak discharges from each of these floods have been abstracted and are given in Table 3. The total flood hydrograph for catchment 1E (rural) and 1E (urban) are shown in Figures 6 and 7 respectively. Figures 8 and 9 give 1 in 25 year and 1 in 100 year peak urban flows as a function of distance upstream (as measured along the stream) from point 1E. It may be considered within the accuracy of the method to interpolate between points on this graph to obtain flood estimates at other locations. Extrapolation of Figures 8 and 9 is not recommended.

Conclusions and recommendations

A number of assumptions have had to be made about the unit hydrograph time to peak, antecedent conditions, rainfall profile and in particular percentage runoff. Of necessity, most of these are conservative and may be reviewed when more data become available. For any subsequent work it would be desirable to obtain the complete set of rainfall intensity/duration/frequency curves from Meteorological Note No 19 (Ref 3).

In this analysis it has been assumed that urbanisation is uniform over the whole catchment area. However, because in practice urbanisation is concentrated at the lower end of the catchment, the magnitude of peak discharge will be reduced since, if rainfall is assumed uniform over the catchment, the urban flood peak will have passed downstream before the arrival of the slower response rural flood from the head waters. While the effect of this simplifying assumption is small it will ensure that these flood estimates are conservative.

TABLE 3

Peak flood flows (cumecs)

Catchment	Urbanised Catchment		Rural Catchment	
	25 year	100 year	25 year	100 year
1A	26	33	26	33
1B	105	130	38	47
1C	149	184	48	60
1D	188	233	56	69
1E	543	673	242	302
2A	332	413	206	257
2B	362	450	198*	248*
2C	330*	410*	178*	222*
2D	418	519	205	256
3A	43	54	31	39
3B	93	116	46	57
3C	119	149	51	64
3D	177	220	61	76

* Reduced peak flows relative to point upstream due to the effects of attenuation exceeding those of additional flow from intermediate areas.

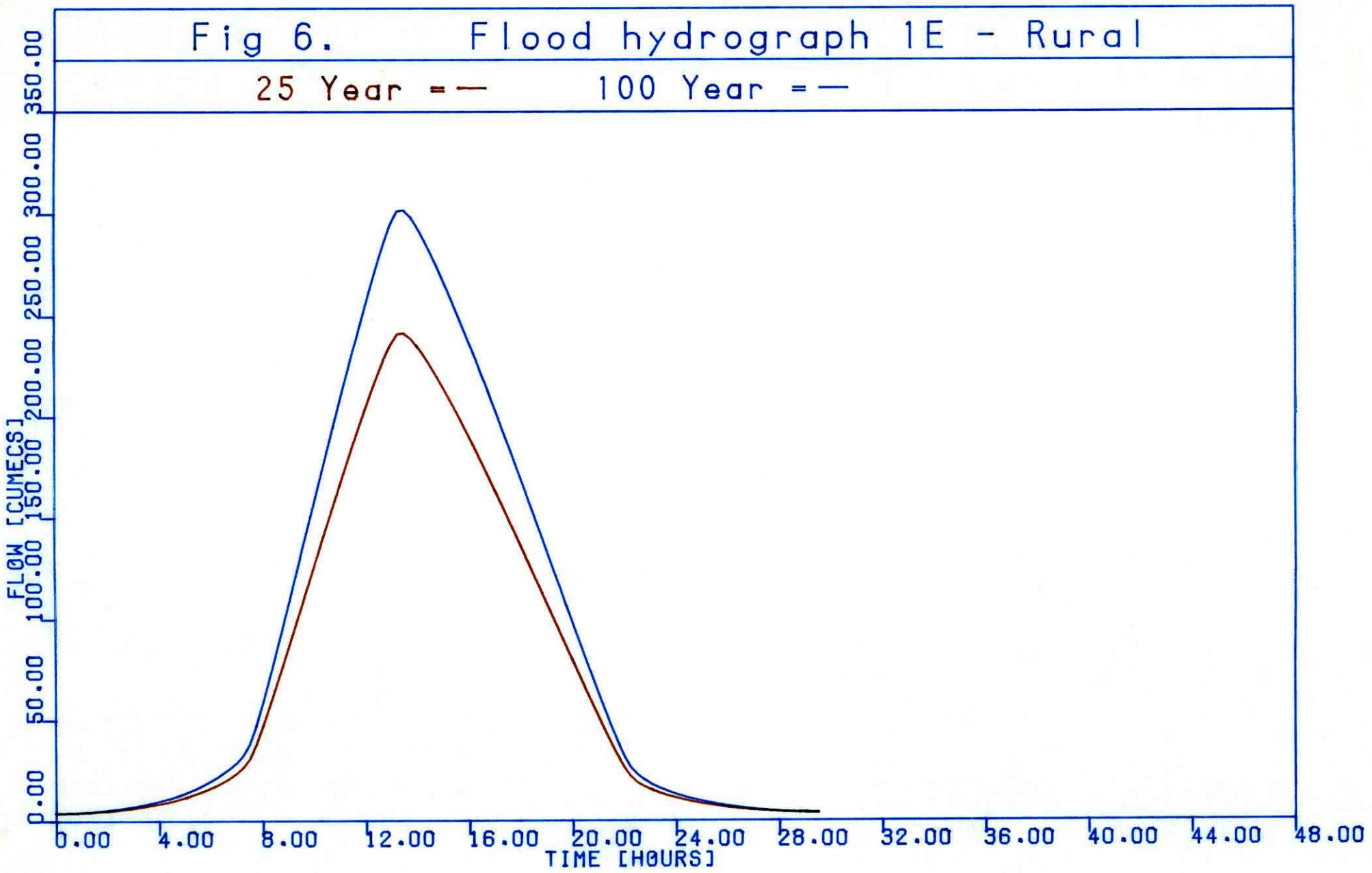


Fig 6. Flood hydrograph 1E - Rural
25 Year = —
100 Year = —
FLOW [CUMECS]
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
36.00
40.00
44.00
48.00
TIME [HOURS]

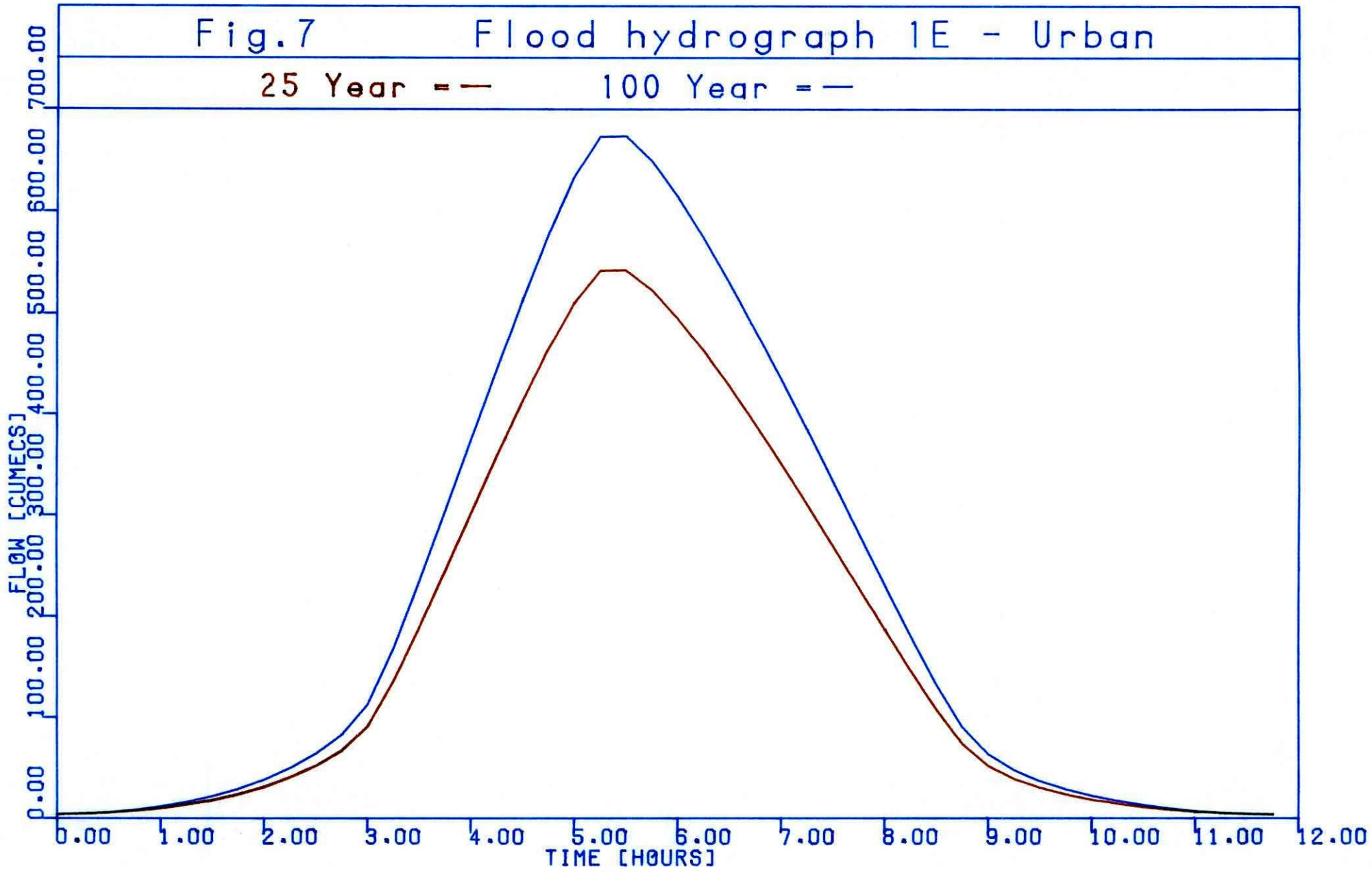


Fig.7 Flood hydrograph 1E - Urban
25 Year = —
100 Year = —
FLOW [CUMECS]
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
TIME [HOURS]

Figure 8

1 IN 25 YEAR PEAK URBAN FLOWS AS A FUNCTION OF DISTANCE UPSTREAM FROM POINT 1E

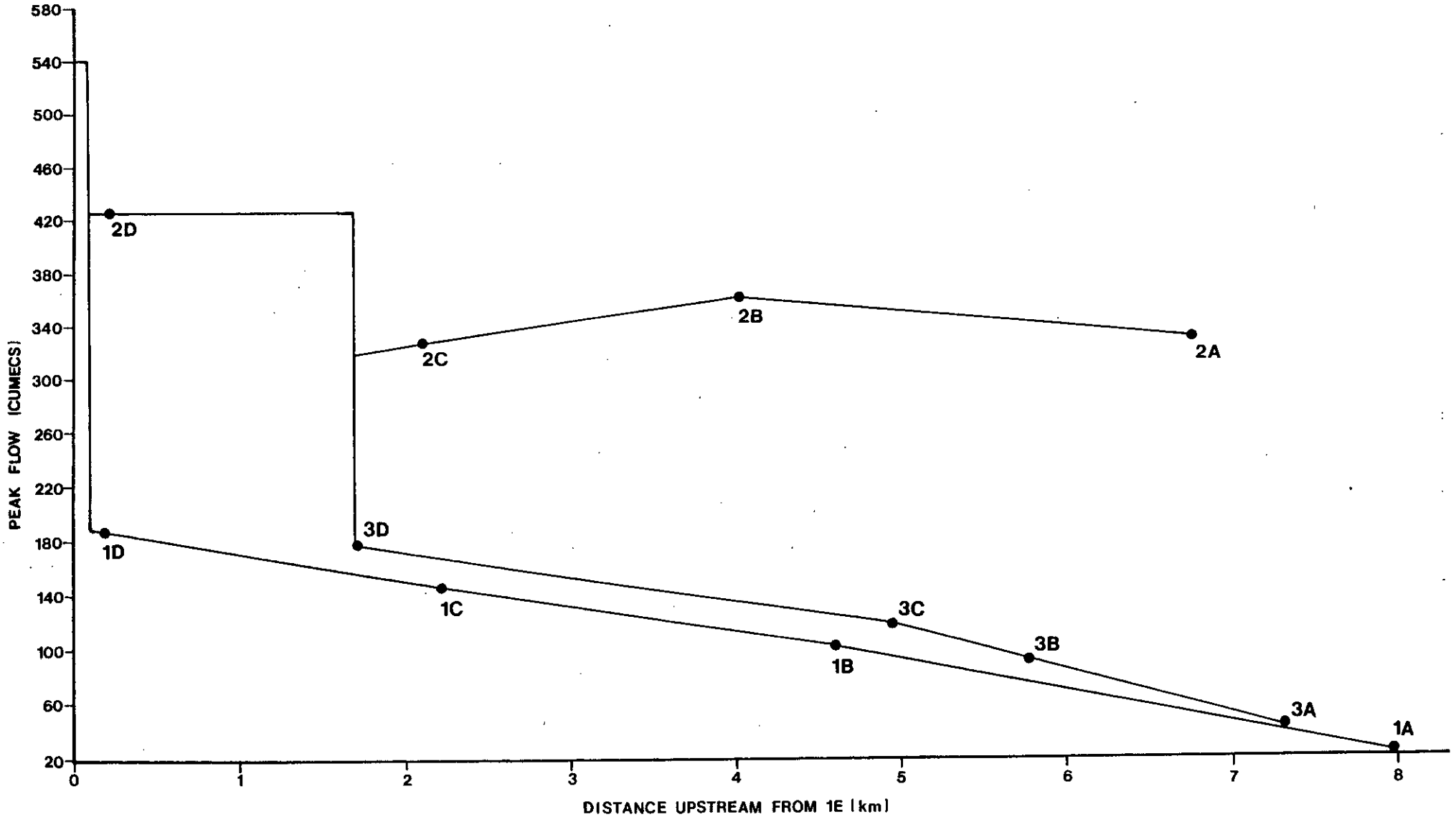
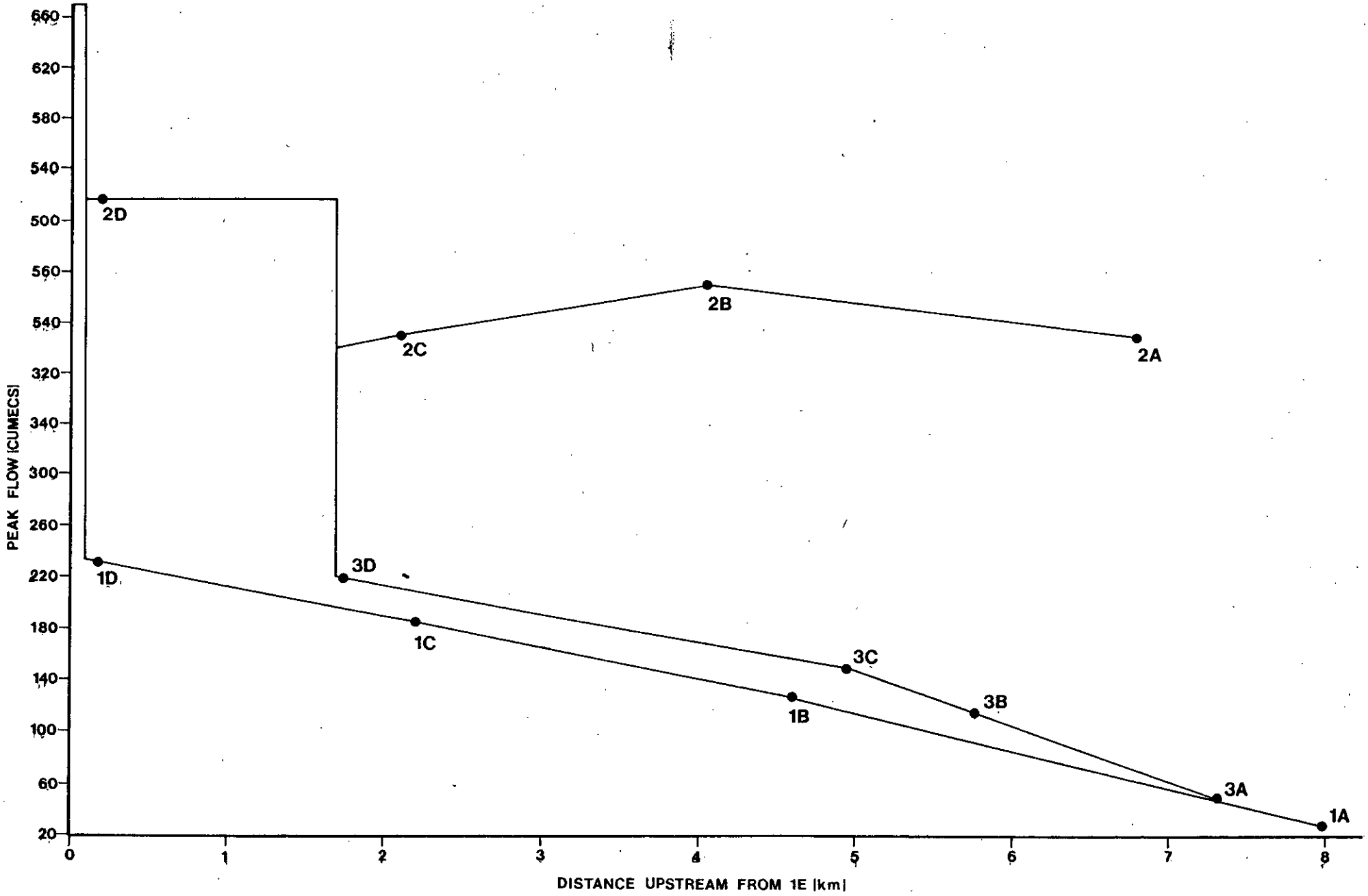


Figure 9 1 IN 100 YEAR PEAK URBAN FLOWS AS A FUNCTION OF DISTANCE UPSTREAM FROM POINT 1E



References

1. Flood Studies Report, 1975, Natural Environment Research Council, London.

2. H P Gauff GmbH and Co, Adejumo Ogunsola and Partners and Noyuk, Feasibility Study and Preliminary Engineering for the Water Supply to the New Federal Capital City, February 1979.

3. Meteorological Service Nigeria, Rainfall Intensity-Duration-Frequency curves for selected Nigerian Stations, Meteorological Note No 19.

4. Institute of Hydrology, Design flood estimation in catchments subject to urbanisation, Flood Studies Supplementary Report No 5, September 1979.

5. Milton Keynes Development Corporation, Phase 1 Area River Catchments, Federal Capital Development Authority Phase 1 area, Abuja, 1:10,000 map drawing no E/282.

APPENDIX A

25 year return period urban catchment floods

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 1A - Urban

Area (Sq.Km.)	2.32
Data interval (Hr)	.25
Design duration (Hr)	2.25
Total rain (mm)	92.75
Percentage runoff	61.22
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= .8

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	2.34	1.43	.00	.09
.25	3.25	1.99	85.94	.37
.50	5.92	3.62	171.88	1.06
.75	14.14	8.66	257.81	2.46
1.00	41.45	25.38	230.07	5.21
1.25	14.14	8.66	173.90	12.41
1.50	5.92	3.62	117.73	20.24
1.75	3.25	1.99	61.56	26.27
2.00	2.34	1.43	5.39	25.44
2.25				21.10
2.50				15.49
2.75				9.57
3.00				4.20
3.25				1.83
3.50				.81
3.75				.32
4.00				.10

Curvature around peak = -105.772

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 18 - Urban

Area (Sq.Km.)	7.41
Data interval (Hr)	.25
Design duration (Hr)	2.25
Total rain (mm)	90.85
Percentage runoff	71.03
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= .7

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	2.41	1.71	.00	.28
.25	3.34	2.37	112.24	1.70
.50	6.01	4.27	224.49	5.10
.75	14.11	10.02	299.61	11.57
1.00	39.11	27.76	226.25	23.85
1.25	14.11	10.02	152.89	55.45
1.50	6.01	4.27	79.53	87.97
1.75	3.34	2.37	6.16	105.29
2.00	2.41	1.71		92.16
2.25				69.50
2.50				43.73
2.75				20.04
3.00				6.89
3.25				3.61
3.50				1.39
3.75				.36

Curvature around peak = -487.970

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 1C - Urban

Area (Sq.Km.)	12.39
Data interval (Hr)	.25
Design duration (Hr)	2.75
Total rain (mm)	93.26
Percentage runoff	73.27
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= .9

Convolution of unit hyorograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.82	1.33	.00	.46
.25	2.45	1.80	67.90	1.59
.50	3.39	2.48	135.80	4.22
.75	6.06	4.44	203.70	8.94
1.00	14.07	10.31	226.69	16.66
1.25	37.69	27.62	182.31	30.93
1.50	14.07	10.31	137.93	65.56
1.75	6.06	4.44	93.55	104.31
2.00	3.39	2.48	49.17	137.36
2.25	2.45	1.80	4.79	148.53
2.50	1.82	1.33		133.07
2.75				106.62
3.00				80.41
3.25				51.46
3.50				25.58
3.75				12.74
4.00				6.60
4.25				3.25
4.50				1.38
4.75				.54

Curvature around peak = -425.969

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 10 - Urban

Area (Sq.Km.)	16.42
Data interval (Hr)	.25
Design duration (Hr)	2.75
Total rain (mm)	92.50
Percentage runoff	74.20
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 1.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.84	1.37	.00	.61
.25	2.47	1.84	55.00	1.65
.50	3.42	2.54	110.00	4.74
.75	6.09	4.52	165.00	9.97
1.00	14.02	10.41	220.00	19.19
1.25	36.80	27.31	184.05	35.81
1.50	14.02	10.41	148.10	74.35
1.75	6.09	4.52	112.16	118.5[illegible]
2.00	3.42	2.54	76.21	159.9[illegible]
2.25	2.47	1.84	40.26	186.21
2.50	1.84	1.37	4.31	177.32
2.75				152.64
3.00				122.66
3.25				90.14
3.50				57.4[illegible]
3.75				26.35
4.00				14.22
4.25				7.43
4.50				3.77
4.75				1.65
5.00				.71

Curvature around peak = -625.939

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 1E - Urban

Area (Sq.Km.)	103.64
Data interval (Hr)	.25
Design duration (Hr)	6.25
Total rain (mm)	100.21
Percentage runoff	69.97
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 2.3

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.74	.52	.00	3.88
.25	.88	.61	10.40	4.43
.50	.96	.67	20.79	5.65
.75	1.05	.74	31.19	7.59
1.00	1.18	.82	41.59	10.32
1.25	1.33	.93	51.98	13.93
1.50	1.63	1.14	62.38	18.55
1.75	2.02	1.42	72.76	24.40
2.00	2.68	1.87	83.18	31.78
2.25	3.65	2.55	93.57	41.17
2.50	6.22	4.35	90.22	52.59
2.75	13.27	9.28	83.42	67.62
3.00	29.02	20.31	76.63	91.49
3.25	13.27	9.28	69.83	135.96
3.50	6.22	4.35	63.03	188.99
3.75	3.65	2.55	56.24	245.05
4.00	2.68	1.87	49.44	301.99
4.25	2.02	1.42	42.65	356.47
4.50	1.63	1.14	35.85	413.32
4.75	1.33	.93	29.06	465.05
5.00	1.18	.82	22.26	510.73
5.25	1.05	.74	15.47	542.49
5.50	.96	.67	8.67	542.78
5.75	.88	.61	1.88	523.32
6.00	.74	.52		495.28
6.25				463.02
6.50				427.63
6.75				390.07
7.00				350.94
7.25				310.71
7.50				269.74
7.75				228.37
8.00				187.01
8.25				146.21
8.50				107.16
8.75				73.52
9.00				52.07
9.25				39.22
9.50				30.44
9.75				23.89
10.00				18.62
10.25				14.53
10.50				11.25
10.75				8.74
11.00				6.79
11.25				5.38
11.50				4.46
11.75				3.95

Curvature around peak = -315.994

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 2A - Urban

Area (Sq.Km.)	57.85
Data interval (Hr)	.25
Design duration (Hr)	5.25
Total rain (mm)	99.59
Percentage runoff	65.91
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 2.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.92	.61	.00	2.16
.25	1.02	.67	13.75	2.05
.50	1.13	.75	27.50	3.66
.75	1.26	.84	41.25	5.27
1.00	1.57	1.04	55.00	7.55
1.25	1.96	1.29	68.75	10.66
1.50	2.61	1.72	82.50	14.79
1.75	3.58	2.36	96.25	20.29
2.00	6.20	4.09	110.00	27.67
2.25	13.62	8.96	101.01	37.50
2.50	31.80	20.96	92.03	53.59
2.75	13.62	8.96	83.04	85.37
3.00	6.20	4.09	74.05	123.18
3.25	3.58	2.36	65.07	162.68
3.50	2.61	1.72	56.08	202.75
3.75	1.96	1.29	47.09	241.73
4.00	1.57	1.04	38.10	278.63
4.25	1.26	.84	29.12	310.99
4.50	1.13	.75	20.13	332.20
4.75	1.02	.67	11.14	326.45
5.00	.92	.61	2.16	309.42
5.25				287.73
5.50				263.28
5.75				236.95
6.00				209.35
6.25				180.90
6.50				151.98
6.75				122.91
7.00				94.12
7.25				66.43
7.50				42.80
7.75				28.57
8.00				20.50
8.25				15.17
8.50				11.28
8.75				8.36
9.00				6.17
9.25				4.55
9.50				3.40
9.75				2.64
10.00				2.24

Curvature around peak = -431.535

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 2b - Urban

Area (Sq.Km.)	64.45
Data interval (Hr)	.25
Design duration (Hr)	5.75
Total rain (mm)	100.84
Percentage runoff	68.03
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 2.1

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.85	.58	.00	2.41
.25	.93	.63	12.47	2.68
.50	1.02	.70	24.94	3.65
.75	1.14	.78	37.41	5.38
1.00	1.29	.88	49.89	7.54
1.25	1.56	1.06	62.36	10.40
1.50	1.97	1.34	74.83	14.12
1.75	2.62	1.78	87.30	18.93
2.00	3.59	2.44	99.77	25.17
2.25	6.21	4.22	99.87	32.91
2.50	13.57	9.23	91.72	43.23
2.75	31.29	21.29	83.57	60.08
3.00	13.57	9.23	75.42	93.06
3.25	6.21	4.22	67.27	132.34
3.50	3.59	2.44	59.11	173.69
3.75	2.62	1.78	50.96	215.36
4.00	1.97	1.34	42.81	256.37
4.25	1.56	1.06	34.66	295.48
4.50	1.29	.88	26.51	330.87
4.75	1.14	.78	18.36	357.28
5.00	1.02	.70	10.21	362.47
5.25	.93	.63	2.05	349.54
5.50	.85	.58		329.07
5.75				305.29
6.00				276.96
6.25				251.10
6.50				222.12
6.75				192.40
7.00				162.27
7.25				132.35
7.50				102.15
7.75				73.44
8.00				48.60
8.25				33.34
8.50				24.56
8.75				18.67
9.00				14.23
9.25				10.66
9.50				8.24
9.75				6.23
10.00				4.71
10.25				3.60
10.50				2.88
10.75				2.49

Curvature around peak = -289.905

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 2C - Urban

Area (Sq.Km.)	66.17
Data interval (Hr)	.25
Design duration (Hr)	6.75
Total rain (mm)	103.33
Percentage runoff	68.28
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 2.5

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.59	.40	.00	2.48
.25	.71	.49	8.80	2.71
.50	.85	.58	17.60	3.23
.75	.93	.63	26.40	4.09
1.00	1.02	.70	35.20	5.39
1.25	1.14	.78	44.00	6.95
1.50	1.29	.88	52.80	9.03
1.75	1.59	1.08	61.60	11.64
2.00	1.97	1.35	70.40	14.87
2.25	2.62	1.79	79.20	18.69
2.50	3.60	2.46	88.00	23.95
2.75	6.21	4.24	82.25	30.05
3.00	13.55	9.25	76.50	38.15
3.25	31.17	21.28	70.75	51.05
3.50	13.55	9.25	64.99	75.79
3.75	6.21	4.24	59.24	105.22
4.00	3.60	2.46	53.49	136.36
4.25	2.62	1.79	47.74	168.08
4.50	1.97	1.35	41.99	199.80
4.75	1.59	1.08	36.24	231.01
5.00	1.29	.88	30.48	261.13
5.25	1.14	.78	24.73	289.39
5.50	1.02	.70	18.98	314.03
5.75	.93	.63	13.23	330.16
6.00	.85	.58	7.48	326.18
6.25	.71	.49	1.73	313.62
6.50	.59	.40		297.37
6.75				279.17
7.00				259.46
7.25				238.65
7.50				217.11
7.75				194.99
8.00				172.44
8.25				149.60
8.50				126.64
8.75				103.74
9.00				81.24
9.25				59.76
9.50				41.23
9.75				29.42
10.00				22.51
10.25				17.78
10.50				14.19
10.75				11.36
11.00				9.19
11.25				7.27
11.50				5.81
11.75				4.65
12.00				3.77
12.25				3.14
12.50				2.73
12.75				2.52

Curvature around peak = -321.935

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 20 - Urban

Area (Sq.Km.)	87.22
Data interval (Hr)	.25
Design duration (Hr)	6.75
Total rain (mm)	102.15
Percentage runoff	69.16
Base flow (cumecs per sq.km)	.037
CWI at start of storm	139.40

Triangular unit hydrograph computed from Tp= 2.6

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.60	.42	.00	3.2[illegible]
.25	.72	.50	8.14	3.56
.50	.87	.60	16.27	4.21
.75	.95	.65	24.41	5.2[illegible]
1.00	1.04	.72	32.54	6.64
1.25	1.16	.80	40.68	8.6[illegible]
1.50	1.32	.91	48.82	11.5[illegible]
1.75	1.61	1.12	56.95	14.7[illegible]
2.00	2.00	1.37	65.09	18.6[illegible]
2.25	2.66	1.84	73.22	23.9[illegible]
2.50	3.63	2.51	81.36	30.2[illegible]
2.75	6.22	4.30	81.42	36.1[illegible]
3.00	13.36	9.25	76.11	46.44
3.25	29.82	20.62	70.79	64.6[illegible]
3.50	13.38	9.25	65.47	94.8[illegible]
3.75	6.22	4.30	60.15	130.7[illegible]
4.00	3.63	2.51	54.84	166.7[illegible]
4.25	2.66	1.84	49.52	207.5[illegible]
4.50	2.00	1.39	44.20	246.4[illegible]
4.75	1.61	1.12	38.88	284.8[illegible]
5.00	1.32	.91	33.57	322.0[illegible]
5.25	1.16	.80	28.25	357.2[illegible]
5.50	1.04	.72	22.93	388.8[illegible]
5.75	.95	.65	17.61	412.4[illegible]
6.00	.87	.60	12.29	417.6[illegible]
6.25	.73	.50	6.96	407.0[illegible]
6.50	.60	.42	1.66	389.[illegible]
6.75				366.5[illegible]
7.00				345.3[illegible]
7.25				330.54
7.50				294.6[illegible]
7.75				267.8[illegible]
8.00				240.47
8.25				212.6[illegible]
8.50				184.41
8.75				156.11
9.00				127.[illegible]
9.25				100.3[illegible]
9.50				74.2[illegible]
9.75				51.74
10.00				37.15
10.25				28.50
10.50				22.57
10.75				18.0[illegible]
11.00				14.4[illegible]
11.25				11.6[illegible]
11.50				9.3[illegible]
11.75				7.4[illegible]
12.00				6.0[illegible]
12.25				4.91
12.50				4.11
12.75				3.5[illegible]
13.00				3.3[illegible]

Curvature around peak = -252.306

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 3A - Urban

Area (Sq.Km.)	6.30
Data interval (Hr)	.25
Design duration (Hr)	4.25
Total rain (mm)	101.98
Percentage runoff	65.15
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 1.6

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.02	.66	.00	.22
.25	1.14	.74	21.48	.31
.50	1.42	.92	42.97	.45
.75	1.78	1.16	64.45	.76
1.00	2.40	1.56	85.94	1.24
1.25	3.32	2.16	107.42	1.89
1.50	5.99	3.90	128.91	2.83
1.75	14.12	9.20	129.07	4.17
2.00	39.62	25.81	115.03	6.55
2.25	14.12	9.20	100.99	12.08
2.50	5.99	3.90	86.95	16.56
2.75	3.32	2.16	72.91	25.24
3.00	2.40	1.56	58.86	31.62
3.25	1.78	1.16	44.82	37.90
3.50	1.42	.92	30.78	42.61
3.75	1.14	.74	16.74	43.37
4.00	1.02	.66	2.70	40.64
4.25				37.19
4.50				32.92
4.75				28.39
5.00				23.66
5.25				18.84
5.50				14.02
5.75				9.35
6.00				5.32
6.25				3.19
6.50				2.10
6.75				1.47
7.00				.97
7.25				.65
7.50				.44
7.75				.30
8.00				.24

Curvature around peak = -52.500

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 3B - Urban

Area (Sq.Km.)	10.64
Data interval (hr)	.25
Design duration (Hr)	3.75
Total rain (mm)	98.56
Percentage runoff	68.83
Base flow (cumecs per sq.km)	.037
CWI at start of storm	135.40

Triangular unit hydrograph computed from Tp= 1.3

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.17	.80	.00	.40
.25	1.45	1.00	32.54	.68
.50	1.81	1.25	65.09	1.30
.75	2.44	1.68	97.63	2.35
1.00	3.37	2.32	130.18	3.99
1.25	6.04	4.16	162.72	6.47
1.50	14.08	9.69	152.21	9.94
1.75	38.14	26.25	130.94	16.26
2.00	14.08	9.69	109.67	30.99
2.25	6.04	4.16	88.40	46.16
2.50	3.37	2.32	67.13	65.57
2.75	2.44	1.68	45.86	81.50
3.00	1.81	1.25	24.59	93.16
3.25	1.45	1.00	3.32	92.11
3.50	1.17	.80		84.11
3.75				73.59
4.00				61.80
4.25				49.35
4.50				36.67
4.75				24.19
5.00				13.27
5.25				7.62
5.50				4.74
5.75				3.00
6.00				1.84
6.25				1.10
6.50				.64
6.75				.47

Curvature around peak = -203.26

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 3C - Urban

Area (Sq.Km.)	12.66
Data interval (Hr)	.25
Design duration (Hr)	3.25
Total rain (mm)	96.12
Percentage runoff	69.56
Base flow (cumecs per sq.km)	.037
CwI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 1.2

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.46	1.01	.00	.47
.25	1.82	1.27	38.19	.97
.50	2.45	1.71	76.39	2.07
.75	3.39	2.36	114.58	4.00
1.00	6.06	4.22	152.78	7.07
1.25	14.06	9.76	178.34	12.07
1.50	37.62	26.17	153.38	20.87
1.75	14.06	9.76	128.41	41.29
2.00	6.06	4.22	103.45	64.99
2.25	3.39	2.36	78.49	88.54
2.50	2.45	1.71	53.52	106.96
2.75	1.82	1.27	28.56	119.75
3.00	1.46	1.01	3.59	112.82
3.25				99.72
3.50				83.92
3.75				66.86
4.00				49.22
4.25				31.86
4.50				16.89
4.75				9.06
5.00				5.27
5.25				3.07
5.50				1.70
5.75				.90
6.00				.52

Curvature around peak = -283.500

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 30 - Urban

Area (Sq.Km.)	19.60
Data interval (Hr)	.25
Design duration (Hr)	3.75
Total rain (mm)	97.35
Percentage runoff	72.66
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 1.3

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit hydrograph ordinate	Total Hydrograph
.00	1.20	.87	.00	.73
.25	1.49	1.08	32.54	1.29
.50	1.86	1.35	65.09	2.54
.75	2.49	1.81	97.63	4.64
1.00	3.44	2.50	130.18	7.91
1.25	6.11	4.44	162.72	12.76
1.50	13.99	10.17	152.21	19.71
1.75	36.20	26.31	130.94	32.06
2.00	13.99	10.17	109.67	59.82
2.25	6.11	4.44	88.40	92.25
2.50	3.44	2.50	67.13	125.02
2.75	2.49	1.81	45.86	155.17
3.00	1.86	1.35	24.59	176.85
3.25	1.49	1.08	3.32	175.10
3.50	1.20	.87		160.21
3.75				140.42
4.00				118.13
4.25				94.51
4.50				70.37
4.75				46.75
5.00				26.04
5.25				15.07
5.50				9.38
5.75				5.92
6.00				3.62
6.25				2.13
6.50				1.22
6.75				.79

Curvature around peak = -375.831

APPENDIX B

100 year return period urban catchment floods

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1A - Urban

Area (Sq.Km.)	2.32
Data interval (Hr)	.25
Design duration (Hr)	2.25
Total rain (mm)	111.16
Percentage runoff	63.64
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= .8

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	2.81	1.74	.00	.06
.25	3.90	2.46	85.94	.45
.50	7.09	4.51	171.88	1.35
.75	16.95	10.79	257.81	3.05
1.00	49.67	31.61	230.07	6.48
1.25	16.95	10.79	173.90	15.44
1.50	7.09	4.51	117.73	25.19
1.75	3.90	2.46	61.56	32.71
2.00	2.81	1.74	5.39	31.07
2.25				26.26
2.50				19.27
2.75				11.95
3.00				5.21
3.25				2.27
3.50				.99
3.75				.39
4.00				.11

Curvature around peak = -136.867

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1a - Urban

Area (Sq.Km.)	7.41
Data interval (Hr)	.25
Design duration (Hr)	2.25
Total rain (mm)	108.66
Percentage runoff	73.41
Base flow (cumecs per sq.km)	.036
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= .7

Convolution of unit hyorograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hyorograph ordinate	Total Hyorograph
.00	2.89	2.12	.00	.28
.25	4.00	2.94	112.24	2.05
.50	7.20	5.29	224.49	6.25
.75	16.91	12.42	299.61	14.27
1.00	46.87	34.41	226.25	29.48
1.25	16.91	12.42	152.89	66.61
1.50	7.20	5.29	79.53	108.85
1.75	4.00	2.94	6.16	130.35
2.00	2.89	2.12		114.08
2.25				86.02
2.50				54.10
2.75				24.79
3.00				10.85
3.25				4.66
3.50				1.67
3.75				.39

Curvature around peak = -604.372

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1C - Urban

Area (Sq.Km.)	12.39
Data interval (Hr)	.25
Design duration (Hr)	2.75
Total rain (mm)	111.77
Percentage runoff	75.70
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= .9

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	2.18	1.65	.00	.47
.25	2.94	2.22	67.90	1.86
.50	4.06	3.07	135.80	5.13
.75	7.26	5.50	203.70	10.97
1.00	16.86	12.76	226.69	20.52
1.25	45.17	34.19	182.31	36.19
1.50	16.86	12.76	137.93	81.07
1.75	7.26	5.50	93.55	129.05
2.00	4.06	3.07	49.17	169.97
2.25	2.94	2.22	4.79	183.79
2.50	2.18	1.65		164.65
2.75				134.39
3.00				99.46
3.25				63.61
3.50				31.57
3.75				15.65
4.00				6.07
4.25				3.43
4.50				1.61
4.75				.57

Curvature around peak = -527.394

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment ID - Urban

Area (Sq.Km.)	16.42
Data interval (Hr)	.25
Design duration (Hr)	2.75
Total rain (mm)	110.86
Percentage runoff	76.61
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 1.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	2.21	1.69	.00	.63
.25	2.97	2.27	55.00	2.16
.50	4.10	3.14	110.00	5.74
.75	7.30	5.59	165.00	12.15
1.00	16.81	12.86	220.00	23.62
1.25	44.11	33.79	184.05	44.18
1.50	16.81	12.86	148.10	91.87
1.75	7.30	5.59	112.16	146.49
2.00	4.10	3.14	76.21	197.62
2.25	2.97	2.27	40.26	232.76
2.50	2.21	1.69	4.31	219.28
2.75				188.99
3.00				151.65
3.25				111.41
3.50				70.90
3.75				34.95
4.00				17.46
4.25				9.06
4.50				4.47
4.75				1.91
5.00				.75

Curvature around peak = -774.516

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1E - Urban

Area (Sq.Km.)	103.64
Data interval (Hr)	.25
Design duration (Hr)	6.25
Total rain (mm)	120.10
Percentage runoff	72.53
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 2.3

Convolution of unit hyorograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hyorograph
.00	.85	.64	.00	3.97
.25	1.05	.76	10.40	4.6[illegible]
.50	1.15	.83	20.79	6.17
.75	1.26	.92	31.19	8.57
1.00	1.41	1.02	41.59	11.97
1.25	1.59	1.16	51.98	16.46
1.50	1.95	1.42	62.38	22.20
1.75	2.42	1.76	72.78	29.47
2.00	3.21	2.33	83.18	36.63
2.25	4.38	3.17	93.57	50.30
2.50	7.45	5.40	90.22	64.47
2.75	15.90	11.53	83.42	83.16
3.00	34.78	25.23	76.63	112.61
3.25	15.90	11.53	69.83	168.05
3.50	7.45	5.40	63.03	233.94
3.75	4.38	3.17	56.24	303.67
4.00	3.21	2.33	49.44	374.32
4.25	2.42	1.76	42.65	444.50
4.50	1.95	1.42	35.85	512.67
4.75	1.59	1.16	29.06	576.93
5.00	1.41	1.02	22.26	633.6[illegible]
5.25	1.26	.92	15.47	673.10
5.50	1.15	.83	8.67	673.47
5.75	1.05	.76	1.88	649.30
6.00	.88	.64		614.4[illegible]
6.25				574.37
6.50				530.41
6.75				483.7[illegible]
7.00				435.14
7.25				385.1[illegible]
7.50				334.2[illegible]
7.75				282.66
8.00				231.4[illegible]
8.25				180.7[illegible]
8.50				132.2[illegible]
8.75				90.4[illegible]
9.00				63.7[illegible]
9.25				47.8[illegible]
9.50				36.97
9.75				26.73
10.00				22.2[illegible]
10.25				17.1[illegible]
10.50				13.17
10.75				10.01
11.00				7.5[illegible]
11.25				5.64
11.50				4.6[illegible]
11.75				4.0[illegible]

Curvature around peak = -392.572

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 2A - Urban

Area (Sq.Km.)	57.85
Data interval (Hr)	.25
Design duration (Hr)	5.25
Total rain (mm)	119.35
Percentage runoff	68.46
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 2.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.10	.76	.00	2.21
.25	1.22	.83	13.75	2.62
.50	1.36	.93	27.50	4.08
.75	1.53	1.05	41.25	6.08
1.00	1.89	1.29	55.00	8.92
1.25	2.35	1.61	68.75	12.79
1.50	3.13	2.14	82.50	17.93
1.75	4.29	2.94	96.25	24.79
2.00	7.43	5.09	110.00	33.96
2.25	16.33	11.16	101.01	46.20
2.50	38.11	26.09	92.03	66.23
2.75	16.33	11.16	83.04	105.79
3.00	7.43	5.09	74.05	152.85
3.25	4.29	2.94	65.07	202.27
3.50	3.13	2.14	56.08	251.91
3.75	2.35	1.61	47.09	300.43
4.00	1.89	1.29	38.10	346.37
4.25	1.53	1.05	29.12	386.64
4.50	1.36	.93	20.13	413.05
4.75	1.22	.83	11.14	405.89
5.00	1.10	.76	2.16	384.69
5.25				357.69
5.50				327.26
5.75				294.48
6.00				260.12
6.25				224.70
6.50				186.79
6.75				152.52
7.00				116.68
7.25				82.21
7.50				52.61
7.75				35.08
8.00				25.04
8.25				18.40
8.50				13.56
8.75				9.93
9.00				7.21
9.25				5.19
9.50				3.75
9.75				2.69
10.00				2.31

Curvature around peak = -537.163

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 2B - Urban

Area (Sq.Km.)	64.45
Data interval (Hr)	.25
Design duration (Hr)	5.75
Total rain (mm)	120.85
Percentage runoff	70.61
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 2.1

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.02	.72	.00	2.47
.25	1.11	.79	12.47	3.05
.50	1.23	.87	24.94	4.26
.75	1.37	.96	37.41	6.16
1.00	1.55	1.09	49.89	8.84
1.25	1.90	1.34	62.36	12.40
1.50	2.36	1.67	74.83	17.03
1.75	3.14	2.22	87.30	23.01
2.00	4.31	3.04	99.77	30.77
2.25	7.44	5.25	99.87	40.40
2.50	16.26	11.48	91.72	53.24
2.75	37.50	26.46	83.57	74.20
3.00	16.26	11.48	75.42	115.22
3.25	7.44	5.25	67.27	164.07
3.50	4.31	3.04	59.11	215.50
3.75	3.14	2.22	50.96	267.34
4.00	2.36	1.67	42.81	318.29
4.25	1.90	1.34	34.66	366.99
4.50	1.55	1.09	26.51	410.94
4.75	1.37	.96	18.36	443.65
5.00	1.23	.87	10.21	450.31
5.25	1.11	.79	2.05	434.23
5.50	1.02	.72		408.77
5.75				379.08
6.00				346.44
6.25				311.79
6.50				275.74
6.75				238.78
7.00				201.30
7.25				165.71
7.50				126.52
7.75				90.81
8.00				59.92
8.25				40.96
8.50				30.01
8.75				22.65
9.00				17.17
9.25				12.97
9.50				9.72
9.75				7.22
10.00				5.32
10.25				3.95
10.50				3.04
10.75				2.56

Curvature around peak = -360.586

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 2C - Urban

Area (Sq.Km.)	66.17
Data interval (Hr)	.25
Design duration (Hr)	6.75
Total rain (mm)	123.64
Percentage runoff	70.90
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 2.5

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.71	.50	.00	2.57
.25	.85	.61	8.80	2.63
.50	1.02	.72	17.60	3.47
.75	1.11	.79	26.40	4.54
1.00	1.23	.87	35.20	6.06
1.25	1.37	.97	44.00	8.10
1.50	1.55	1.10	52.80	10.69
1.75	1.90	1.35	61.60	13.93
2.00	2.37	1.68	70.40	17.95
2.25	3.15	2.23	79.20	22.95
2.50	4.31	3.06	88.00	29.25
2.75	7.44	5.27	82.25	36.85
3.00	16.24	11.52	76.50	46.93
3.25	37.35	26.46	70.75	63.02
3.50	16.24	11.52	64.99	93.77
3.75	7.44	5.27	59.24	130.39
4.00	4.31	3.06	53.49	169.15
4.25	3.15	2.23	47.74	206.67
4.50	2.37	1.68	41.99	248.11
4.75	1.90	1.35	36.24	286.95
5.00	1.55	1.10	30.48	324.43
5.25	1.37	.97	24.73	359.60
5.50	1.23	.87	18.98	390.26
5.75	1.11	.79	13.23	410.34
6.00	1.02	.72	7.48	405.38
6.25	.85	.61	1.73	389.74
6.50	.71	.50		369.54
6.75				346.69
7.00				322.35
7.25				296.49
7.50				269.65
7.75				242.17
8.00				214.05
8.25				185.63
8.50				157.05
8.75				128.56
9.00				100.56
9.25				73.82
9.50				50.76
9.75				36.06
10.00				27.46
10.25				21.59
10.50				17.12
10.75				13.59
11.00				10.77
11.25				8.50
11.50				6.68
11.75				5.24
12.00				4.14
12.25				3.35
12.50				2.65
12.75				2.59

Curvature around peak = -400.655

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 20 - Urban

Area (Sq.Km.)	87.22
Data interval (Hr)	.25
Design duration (Hr)	6.75
Total rain (mm)	122.43
Percentage runoff	71.76
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 2.6

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.72	.52	.00	3.34
.25	.87	.63	8.14	3.71
.50	1.04	.75	16.27	4.52
.75	1.13	.81	24.41	5.86
1.00	1.25	.90	32.54	7.78
1.25	1.39	1.00	40.68	10.34
1.50	1.58	1.13	48.82	13.60
1.75	1.93	1.39	56.95	17.67
2.00	2.40	1.72	65.09	22.72
2.25	3.19	2.29	73.22	29.00
2.50	4.35	3.12	81.36	36.90
2.75	7.45	5.35	81.42	46.65
3.00	16.03	11.51	76.11	59.51
3.25	35.74	25.65	70.79	79.72
3.50	16.03	11.51	65.47	117.20
3.75	7.45	5.35	60.15	161.83
4.00	4.35	3.12	54.84	209.17
4.25	3.19	2.29	49.52	257.38
4.50	2.40	1.72	44.20	305.74
4.75	1.93	1.39	38.88	353.47
5.00	1.58	1.13	33.57	399.75
5.25	1.39	1.00	28.25	443.57
5.50	1.25	.90	22.93	482.67
5.75	1.13	.81	17.61	512.20
6.00	1.04	.75	12.29	518.65
6.25	.87	.63	6.98	505.48
6.50	.72	.52	1.66	483.60
6.75				457.5[illegible]
7.00				426.6[illegible]
7.25				397.8[illegible]
7.50				365.8[illegible]
7.75				332.3[illegible]
8.00				298.3[illegible]
8.25				263.8[illegible]
8.50				228.8[illegible]
8.75				193.4[illegible]
9.00				158.3[illegible]
9.25				124.04
9.50				91.6[illegible]
9.75				63.62
10.00				45.4[illegible]
10.25				34.7[illegible]
10.50				27.34
10.75				21.72
11.00				17.2[illegible]
11.25				13.74
11.50				10.6[illegible]
11.75				8.5[illegible]
12.00				6.7[illegible]
12.25				5.3[illegible]
12.50				4.3[illegible]
12.75				3.7[illegible]
13.00				3.41

Curvature around peak = -313.746

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 3A - Urban

Area (Sq.Km.)	6.00
Data interval (Hr)	.25
Design duration (Hr)	4.25
Total rain (mm)	122.22
Percentage runoff	67.74
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 1.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.22	.86	.00	.29
.25	1.37	.93	21.48	.34
.50	1.70	1.15	42.97	.58
.75	2.13	1.44	64.45	.94
1.00	2.87	1.94	85.94	1.50
1.25	3.98	2.69	107.42	2.31
1.50	7.18	4.86	128.91	3.47
1.75	16.93	11.47	129.07	5.14
2.00	47.48	32.16	115.03	8.11
2.25	16.93	11.47	100.99	15.00
2.50	7.18	4.86	86.95	23.09
2.75	3.98	2.69	72.91	31.43
3.00	2.87	1.94	58.86	39.60
3.25	2.13	1.44	44.82	47.18
3.50	1.70	1.15	30.78	53.06
3.75	1.37	.93	16.74	53.99
4.00	1.22	.86	2.70	50.84
4.25				46.25
4.50				40.98
4.75				35.32
5.00				29.43
5.25				23.43
5.50				17.42
5.75				11.60
6.00				6.57
6.25				3.92
6.50				2.57
6.75				1.73
7.00				1.16
7.25				.76
7.50				.49
7.75				.33
8.00				.24

Curvature around peak = -65.427

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 36 - Urban

Area (Sq.Km.)	10.64
Data interval (Hr)	.25
Design duration (Hr)	3.75
Total rain (mm)	118.49
Percentage runoff	71.37
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 1.3

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.40	1.00	.00	.41
.25	1.73	1.24	32.54	.75
.50	2.17	1.55	65.09	1.53
.75	2.92	2.06	97.63	2.84
1.00	4.04	2.88	130.18	4.87
1.25	7.24	5.17	162.72	7.90
1.50	16.86	12.05	152.21	12.27
1.75	45.71	32.62	130.94	20.12
2.00	16.88	12.05	109.67	36.42
2.25	7.24	5.17	88.40	59.76
2.50	4.04	2.88	67.13	81.32
2.75	2.92	2.06	45.86	101.19
3.00	2.17	1.55	24.59	115.67
3.25	1.73	1.24	3.32	114.34
3.50	1.40	1.00		104.42
3.75				91.35
4.00				76.71
4.25				61.23
4.50				45.47
4.75				29.99
5.00				16.40
5.25				9.39
5.50				5.80
5.75				3.63
6.00				2.20
6.25				1.27
6.50				.71
6.75				.44

Curvature around peak = -252.574

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 3C - Urban

Area (Sq.Km.)	12.68
Data interval (Hr)	.25
Design duration (Hr)	3.25
Total rain (mm)	115.19
Percentage runoff	72.04
Base flow (cumecs per sq.km)	.036
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 1.2

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.75	1.26	.00	.49
.25	2.19	1.57	38.19	1.09
.50	2.94	2.12	76.39	2.47
.75	4.06	2.93	114.58	4.66
1.00	7.26	5.23	152.78	8.69
1.25	16.85	12.14	178.34	14.63
1.50	45.09	32.48	153.38	25.80
1.75	16.85	12.14	128.41	51.15
2.00	7.26	5.23	103.45	80.56
2.25	4.06	2.93	78.49	109.79
2.50	2.94	2.12	53.52	135.13
2.75	2.19	1.57	28.56	148.53
3.00	1.75	1.26	3.59	139.93
3.25				123.66
3.50				104.06
3.75				82.69
4.00				60.99
4.25				39.44
4.50				20.61
4.75				11.14
5.00				6.44
5.25				3.79
5.50				2.01
5.75				1.01
6.00				.54

Curvature around peak = -351.880

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 30 - Urban

Area (Sq.Km.)	19.66
Data interval (Hr)	.25
Design duration (Hr)	3.75
Total rain (mm)	116.67
Percentage runoff	75.19
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 1.3

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	1.44	1.08	.00	.75
.25	1.78	1.34	32.54	1.44
.50	2.23	1.67	65.09	2.99
.75	2.99	2.25	97.63	5.60
1.00	4.12	3.10	130.18	9.64
1.25	7.32	5.50	162.72	15.66
1.50	16.77	12.61	152.21	24.25
1.75	43.39	32.62	130.94	39.59
2.00	16.77	12.61	109.67	74.00
2.25	7.32	5.50	88.40	114.21
2.50	4.12	3.10	67.13	154.84
2.75	2.99	2.25	45.86	192.15
3.00	2.23	1.67	24.59	219.10
3.25	1.78	1.34	3.32	216.92
3.50	1.44	1.08		198.46
3.75				173.93
4.00				146.29
4.25				117.01
4.50				87.05
4.75				57.68
5.00				32.13
5.25				16.52
5.50				11.47
5.75				7.18
6.00				4.37
6.25				2.49
6.50				1.36
6.75				.82

Curvature around peak = -465.904

APPENDIX C

25 year return period rural catchment floods

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 1A - Rural

Area (Sq.Km.)	2.32
Data interval (Hr)	.25
Design duration (Hr)	2.25
Total rain (mm)	92.75
Percentage runoff	61.22
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= .8

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	2.34	1.43	.00	.09
.25	3.25	1.99	85.94	.37
.50	5.92	3.62	171.88	1.06
.75	14.14	8.66	257.81	2.46
1.00	41.45	25.36	230.07	5.21
1.25	14.14	8.66	173.90	12.41
1.50	5.92	3.62	117.73	20.24
1.75	3.25	1.99	61.56	26.27
2.00	2.34	1.43	5.39	25.44
2.25				21.10
2.50				15.49
2.75				9.57
3.00				4.20
3.25				1.87
3.50				.81
3.75				.33
4.00				.10

Curvature around peak = -109.872

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 1b - Rural

Area (Sq.Km.)	7.41
Data interval (Hr)	.25
Design duration (Hr)	6.25
Total rain (mm)	107.95
Percentage runoff	62.74
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 2.4

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total hydrograph
.00	.64	.40	.00	.24
.25	.77	.48	9.55	.31
.50	.64	.53	19.10	.37
.75	.92	.56	28.65	.47
1.00	1.02	.64	38.19	.61
1.25	1.15	.72	47.74	.79
1.50	1.43	.90	57.29	1.03
1.75	1.79	1.12	66.84	1.33
2.00	2.41	1.51	76.39	1.71
2.25	3.34	2.09	85.94	2.20
2.50	6.01	3.77	69.17	2.81
2.75	14.11	8.85	82.93	3.65
3.00	39.11	24.54	76.69	5.05
3.25	14.11	8.85	70.45	8.17
3.50	6.01	3.77	64.21	11.75
3.75	3.34	2.09	57.97	15.56
4.00	2.41	1.51	51.72	19.44
4.25	1.79	1.12	45.48	23.30
4.50	1.43	.90	39.24	27.09
4.75	1.15	.72	33.00	30.75
5.00	1.02	.64	26.76	34.13
5.25	.92	.58	20.52	36.87
5.50	.84	.53	14.28	37.89
5.75	.77	.48	8.04	36.81
6.00	.64	.40	1.80	34.66
6.25				32.79
6.50				30.47
6.75				27.93
7.00				25.34
7.25				22.65
7.50				19.97
7.75				17.22
8.00				14.47
8.25				11.71
8.50				8.99
8.75				6.40
9.00				4.15
9.25				2.62
9.50				2.12
9.75				1.65
10.00				1.31
10.25				1.04
10.50				.83
10.75				.66
11.00				.53
11.25				.43
11.50				.36
11.75				.31
12.00				.28

Curvature around peak = -33.596

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 1C - Rural

Area (Sq.Km.)	12.39
Data interval (Hr)	.25
Design duration (Hr)	8.75
Total rain (mm)	111.71
Percentage runoff	63.12
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 3.4

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.41	.26	.00	.46
.25	.43	.27	4.76	.49
.50	.46	.29	9.52	.51
.75	.49	.31	14.27	.56
1.00	.53	.33	19.03	.63
1.25	.65	.41	23.79	.71
1.50	.76	.47	28.55	.82
1.75	.85	.54	33.30	.96
2.00	.94	.59	38.06	1.17
2.25	1.04	.66	42.82	1.34
2.50	1.18	.74	47.58	1.59
2.75	1.46	.92	52.34	1.88
3.00	1.82	1.15	57.09	2.22
3.25	2.45	1.55	61.85	2.63
3.50	3.39	2.14	63.46	3.17
3.75	6.06	3.82	60.35	3.71
4.00	14.07	8.86	57.24	4.51
4.25	37.69	23.79	54.13	5.79
4.50	14.07	8.86	51.02	6.49
4.75	6.06	3.82	47.91	11.59
5.00	3.39	2.14	44.80	14.92
5.25	2.45	1.55	41.69	18.32
5.50	1.82	1.15	38.58	21.76
5.75	1.46	.92	35.48	25.20
6.00	1.18	.74	32.37	28.63
6.25	1.04	.66	29.26	32.03
6.50	.94	.59	26.15	35.37
6.75	.85	.54	23.04	38.69
7.00	.76	.47	19.93	41.77
7.25	.65	.41	16.82	44.59
7.50	.53	.33	13.71	46.89
7.75	.49	.31	10.60	47.77
8.00	.46	.29	7.49	46.94
8.25	.43	.27	4.38	45.45
8.50	.41	.26	1.27	43.69
8.75				41.74
9.00				39.67
9.25				37.51
9.50				35.28
9.75				33.00
10.00				30.67

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10.25	26.3[illegible]
10.50	25.6[illegible]
10.75	23.47
11.00	21.0[illegible]
11.25	18.5[illegible]
11.50	16.1[illegible]
11.75	13.7[illegible]
12.00	11.3[illegible]
12.25	8.99
12.50	6.77
12.75	4.62
13.00	3.54
13.25	2.6[illegible]
13.50	2.3[illegible]
13.75	2.01
14.00	1.72
14.25	1.4[illegible]
14.50	1.27
14.75	1.1[illegible]
15.00	.9[illegible]
15.25	.64
15.50	.74
15.75	.66
16.00	.59
16.25	.54
16.50	.51
16.75	.4[illegible]
17.00	.47

Curvature around peak = -27.50[illegible]

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 10 - Rural

Area (Sq.Km.)	16.42
Data interval (hr)	.25
Design duration (Hr)	10.75
Total rain (mm)	114.13
Percentage runoff	63.36
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 4.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.34	.26	.00	.69
.25	.36	.28	3.44	.63
.50	.37	.24	6.88	.65
.75	.39	.29	10.31	.69
1.00	.42	.26	13.75	.74
1.25	.44	.26	17.19	.81
1.50	.47	.30	20.62	.89
1.75	.50	.36	24.06	.99
2.00	.54	.34	27.50	1.11
2.25	.66	.46	30.94	1.25
2.50	.79	.50	34.38	1.41
2.75	.86	.55	37.81	1.60
3.00	.95	.60	41.25	1.82
3.25	1.06	.67	44.69	2.07
3.50	1.19	.79	48.12	2.36
3.75	1.47	.93	51.56	2.70
4.00	1.84	1.17	55.00	3.08
4.25	2.47	1.57	52.75	3.51
4.50	3.42	2.17	50.51	4.01
4.75	6.09	3.86	48.26	4.61
5.00	14.02	8.89	46.01	5.49
5.25	36.80	23.34	43.77	6.68
5.50	14.02	8.89	41.52	9.24
5.75	6.09	3.86	39.27	12.28
6.00	3.42	2.17	37.03	15.58
6.25	2.47	1.57	34.78	18.89
6.50	1.84	1.17	32.53	22.18
6.75	1.47	.93	30.29	25.56
7.00	1.19	.79	28.04	28.94
7.25	1.06	.67	25.79	32.32
7.50	.95	.60	23.55	35.06
7.75	.86	.55	21.30	36.97
8.00	.79	.50	19.05	42.22
8.25	.66	.42	16.81	45.40
8.50	.54	.34	14.56	46.45
8.75	.50	.32	12.31	51.31
9.00	.47	.30	10.07	53.84
9.25	.44	.28	7.82	55.55
9.50	.42	.26	5.57	55.15
9.75	.39	.25	3.33	53.64
10.00	.37	.24	1.08	52.23

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10.25	.36	.23	50.44
10.50	.34	.22	48.57
10.75			46.51
11.00			44.42
11.25			42.28
11.50			40.08
11.75			37.83
12.00			35.59
12.25			33.23
12.50			30.89
12.75			28.53
13.00			26.16
13.25			23.78
13.50			21.41
13.75			19.07
14.00			16.84
14.25			14.79
14.50			11.99
14.75			9.79
15.00			7.56
15.25			5.64
15.50			4.39
15.75			3.59
16.00			3.08
16.25			2.69
16.50			2.37
16.75			2.10
17.00			1.84
17.25			1.66
17.50			1.48
17.75			1.37
18.00			1.19
18.25			1.04
18.50			.96
18.75			.90
19.00			.83
19.25			.77
19.50			.72
19.75			.68
20.00			.65
20.25			.63
20.50			.62

Curvature around peak = -34.571

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 1E - Rural

Area (Sq.Km.)	103.64
Data interval (Hr)	.25
Design duration (Hr)	15.25
Total rain (mm.)	114.34
Percentage runoff	63.38
Base flow (cumecs per sq.km)	.037
CWI at start of storm	139.40

Triangular unit hydrograph computed from Tp= 5.8

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.26	.16	.00	3.8[illegible]
.25	.26	.17	1.63	3.9[illegible]
.50	.27	.17	3.27	3.9[illegible]
.75	.28	.18	4.90	4.05
1.00	.29	.19	6.54	4.1[illegible]
1.25	.31	.19	8.17	4.3[illegible]
1.50	.33	.21	9.81	4.4[illegible]
1.75	.35	.22	11.44	4.7[illegible]
2.00	.37	.23	13.08	4.9[illegible]
2.25	.38	.24	14.71	5.2[illegible]
2.50	.40	.25	16.35	5.5[illegible]
2.75	.42	.27	17.98	5.9[illegible]
3.00	.45	.28	19.62	6.3[illegible]
3.25	.47	.30	21.25	6.6[illegible]
3.50	.50	.32	22.89	7.3[illegible]
3.75	.53	.34	24.52	7.9[illegible]
4.00	.57	.36	26.16	8.5[illegible]
4.25	.61	.39	27.79	9.2[illegible]
4.50	.74	.47	29.43	10.04
4.75	.88	.55	31.06	10.87
5.00	.96	.61	32.70	11.81
5.25	1.05	.67	34.33	12.64
5.50	1.18	.75	35.97	13.99
5.75	1.33	.84	37.60	15.26
6.00	1.63	1.03	37.06	16.64
6.25	2.02	1.28	36.01	18.15
6.50	2.68	1.70	34.94	19.87
6.75	3.65	2.31	33.87	21.7[illegible]
7.00	6.22	3.94	32.80	24.00
7.25	13.27	8.41	31.73	26.67
7.50	29.02	18.40	30.66	31.11
7.75	13.27	8.41	29.60	36.40
8.00	6.22	3.94	28.53	47.05
8.25	3.65	2.31	27.46	56.3[illegible]
8.50	2.66	1.70	26.39	65.8[illegible]
8.75	2.02	1.28	25.32	75.67
9.00	1.63	1.03	24.25	85.5[illegible]
9.25	1.33	.84	23.19	95.6[illegible]
9.50	1.18	.75	22.12	105.6[illegible]
9.75	1.05	.67	21.05	115.7[illegible]
10.00	.96	.61	19.98	125.91

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10.25	.68	.55	18.91	136.07
10.50	.74	.47	17.84	146.11
10.75	.61	.39	16.77	156.12
11.00	.57	.36	15.70	166.09
11.25	.53	.34	14.64	175.82
11.50	.50	.32	13.57	185.46
11.75	.47	.30	12.50	194.92
12.00	.45	.28	11.43	204.18
12.25	.42	.27	10.36	213.09
12.50	.40	.25	9.29	221.67
12.75	.38	.24	8.22	229.59
13.00	.37	.23	7.16	236.57
13.25	.35	.22	6.09	241.59
13.50	.33	.21	5.02	241.66
13.75	.31	.19	3.95	239.34
14.00	.29	.19	2.88	235.51
14.25	.28	.18	1.81	230.94
14.50	.27	.17	.74	225.94
14.75	.26	.17		220.56
15.00	.26	.16		214.94
15.25				209.11
15.50				203.09
15.75				196.89
16.00				190.54
16.25				184.05
16.50				177.46
16.75				170.77
17.00				164.01
17.25				157.18
17.50				150.29
17.75				143.34
18.00				136.35
18.25				129.31
18.50				122.24
18.75				115.17
19.00				108.01
19.25				100.84
19.50				93.71
19.75				86.57
20.00				79.44
20.25				72.34
20.50				65.28
20.75				58.27
21.00				51.34
21.25				44.55
21.50				37.97
21.75				31.71
22.00				26.03
22.25				21.61
22.50				18.90
22.75				16.97
23.00				15.43
23.25				14.11
23.50				12.97
23.75				11.98
24.00				11.07
24.25				10.26
24.50				9.57
24.75				8.89
25.00				8.25
25.25				7.75
25.50				7.27
25.75				6.83
26.00				6.43
26.25				6.06
26.50				5.73
26.75				5.43
27.00				5.17
27.25				4.93
27.50				4.72
27.75				4.54
28.00				4.38
28.25				4.24
28.50				4.17
28.75				4.04
29.00				3.97
29.25				3.92
29.50				3.89

Curvature around peak = -44.057

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 2A - Rural

Area (Sq.Km.)	57.85
Data interval (Hr)	.25
Design duration (Hr)	9.25
Total rain (mm)	108.67
Percentage runoff	62.81
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 3.5

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.43	.27	.00	2.16
.25	.45	.28	4.49	2.27
.50	.48	.30	8.98	2.38
.75	.51	.32	13.47	2.60
1.00	.54	.34	17.96	2.90
1.25	.58	.37	22.45	3.29
1.50	.71	.44	26.94	3.75
1.75	.84	.53	31.43	4.39
2.00	.92	.58	35.92	5.13
2.25	1.02	.64	40.41	6.00
2.50	1.13	.71	44.90	7.07
2.75	1.28	.80	49.39	8.32
3.00	1.57	.99	53.88	9.77
3.25	1.96	1.23	58.37	11.49
3.50	2.61	1.64	62.86	13.50
3.75	3.56	2.25	59.92	15.64
4.00	6.20	3.89	56.99	16.64
4.25	13.62	8.56	54.05	22.32
4.50	31.80	19.97	51.12	28.09
4.75	13.62	8.56	48.18	36.69
5.00	6.20	3.89	45.25	51.77
5.25	3.56	2.25	42.32	65.47
5.50	2.61	1.64	39.38	79.52
5.75	1.96	1.23	36.45	93.75
6.00	1.57	.99	33.51	106.07
6.25	1.28	.80	30.58	122.25
6.50	1.13	.71	27.64	136.34
6.75	1.02	.64	24.71	150.19
7.00	.92	.58	21.77	163.65
7.25	.84	.53	18.84	176.61
7.50	.71	.44	15.91	188.72
7.75	.58	.37	12.97	199.26
8.00	.54	.34	10.04	206.27
8.25	.51	.32	7.10	204.71
8.50	.48	.30	4.17	199.60
8.75	.45	.28	1.23	192.89
9.00	.43	.27		185.31
9.25				177.15
9.50				168.51
9.75				159.49
10.00				150.19

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10.25	140.64
10.50	130.89
10.75	120.97
11.00	110.92
11.25	100.79
11.50	90.61
11.75	80.41
12.00	70.24
12.25	60.12
12.50	50.13
12.75	40.37
13.00	31.15
13.25	23.09
13.50	17.53
13.75	14.27
14.00	12.01
14.25	10.29
14.50	8.81
14.75	7.60
15.00	6.59
15.25	5.71
15.50	4.97
15.75	4.34
16.00	3.82
16.25	3.39
16.50	3.04
16.75	2.75
17.00	2.53
17.25	2.34
17.50	2.20
17.75	2.15

Curvature around peak = -135.836

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 2b - Rural

Area (Sq.Km.)	64.45
Data interval (Hr)	.25
Design duration (Hr)	11.25
Total rain (mm)	111.33
Percentage runoff	63.06
Base flow (cumecs per sq.km)	.037
CWI at start of storm	158.46

Triangular unit hydrograph computed from Tp= 4.2

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.35	.22	.00	2.41
.25	.37	.23	3.12	2.46
.50	.39	.24	6.24	2.55
.75	.41	.26	9.35	2.69
1.00	.43	.27	12.47	2.85
1.25	.49	.29	15.59	3.17
1.50	.49	.30	18.71	3.43
1.75	.51	.32	21.83	3.80
2.00	.55	.35	24.94	4.23
2.25	.59	.37	28.06	4.77
2.50	.71	.45	31.18	5.30
2.75	.85	.54	34.30	5.97
3.00	.93	.59	37.41	6.74
3.25	1.02	.65	40.53	7.67
3.50	1.14	.72	43.65	8.65
3.75	1.29	.81	46.77	9.67
4.00	1.58	1.00	49.89	11.19
4.25	1.97	1.24	51.97	12.64
4.50	2.62	1.65	49.94	14.35
4.75	3.59	2.27	47.90	16.29
5.00	6.21	3.91	45.86	18.61
5.25	13.57	8.56	43.82	21.67
5.50	31.29	19.74	41.78	26.27
5.75	13.57	8.56	39.75	34.79
6.00	6.21	3.91	37.71	44.92
6.25	3.59	2.27	35.67	55.73
6.50	2.62	1.65	33.63	66.65
6.75	1.97	1.24	31.59	76.27
7.00	1.58	1.00	29.56	89.05
7.25	1.29	.81	27.52	101.15
7.50	1.14	.72	25.48	112.58
7.75	1.02	.65	23.44	123.94
8.00	.93	.59	21.41	135.15
8.25	.85	.54	19.37	146.26
8.50	.71	.45	17.33	157.09
8.75	.59	.37	15.29	167.58
9.00	.55	.35	13.25	177.55
9.25	.51	.32	11.22	186.77
9.50	.48	.30	9.18	194.36
9.75	.45	.29	7.14	198.47
10.00	.43	.27	5.10	196.82

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10.25	.41	.26	3.06	192.68
10.50	.39	.24	1.03	187.41
10.75	.37	.23		181.49
11.00	.35	.22		175.13
11.25				168.44
11.50				161.47
11.75				154.27
12.00				146.87
12.25				139.30
12.50				131.57
12.75				123.72
13.00				115.78
13.25				107.76
13.50				99.70
13.75				91.61
14.00				83.49
14.25				75.37
14.50				67.26
14.75				59.19
15.00				51.19
15.25				43.29
15.50				35.59
15.75				28.30
16.00				21.62
16.25				17.20
16.50				14.44
16.75				12.51
17.00				10.98
17.25				9.71
17.50				8.62
17.75				7.69
18.00				6.87
18.25				6.16
18.50				5.54
18.75				4.99
19.00				4.52
19.25				4.12
19.50				3.76
19.75				3.44
20.00				3.25
20.25				2.98
20.50				2.80
20.75				2.66
21.00				2.55
21.25				2.47
21.50				2.43

Curvature around peak = -92.133

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 2C - Rural

Area (Sq.Km.)	66.17
Data interval (Hr)	.25
Design duration (Hr)	13.25
Total rain (mm)	113.72
Percentage runoff	63.32
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 5.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.28	.18	.00	2.48
.25	.30	.19	2.20	2.59
.50	.32	.20	4.40	2.56
.75	.34	.22	6.60	2.64
1.00	.35	.22	8.80	2.75
1.25	.37	.23	11.00	2.90
1.50	.39	.25	13.20	3.08
1.75	.41	.26	15.40	3.30
2.00	.43	.27	17.60	3.58
2.25	.45	.29	19.80	3.88
2.50	.48	.31	22.00	4.18
2.75	.51	.33	24.20	4.56
3.00	.55	.35	26.40	4.99
3.25	.59	.37	28.60	5.47
3.50	.71	.45	30.80	6.05
3.75	.85	.54	33.00	6.60
4.00	.93	.59	35.20	7.28
4.25	1.02	.65	37.40	8.04
4.50	1.14	.72	39.60	8.97
4.75	1.29	.82	41.80	9.86
5.00	1.59	1.00	44.00	10.94
5.25	1.97	1.25	42.56	12.19
5.50	2.62	1.66	41.12	13.45
5.75	3.60	2.28	39.69	14.96
6.00	6.21	3.93	38.25	16.78
6.25	12.55	8.50	36.81	19.07
6.50	31.17	19.75	35.37	22.59
6.75	13.55	8.58	33.93	28.85
7.00	6.21	3.93	32.50	36.47
7.25	3.60	2.28	31.06	44.44
7.50	2.62	1.66	29.62	52.65
7.75	1.97	1.25	28.18	61.13
8.00	1.59	1.00	26.75	69.69
8.25	1.29	.82	25.31	78.25
8.50	1.14	.72	23.87	86.99
8.75	1.02	.65	22.43	95.56
9.00	.93	.59	20.99	104.16
9.25	.85	.54	19.56	112.78
9.50	.71	.45	18.12	121.17
9.75	.59	.37	16.68	129.52
10.00	.55	.35	15.24	137.74

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10.25	.51	.33	13.60	145.74
10.50	.48	.31	12.37	153.53
10.75	.45	.29	10.93	160.95
11.00	.43	.27	9.49	167.85
11.25	.41	.26	8.05	173.86
11.50	.39	.25	6.61	177.83
11.75	.37	.23	5.18	177.09
12.00	.35	.22	3.74	174.32
12.25	.34	.22	2.30	170.67
12.50	.32	.20	.86	166.43
12.75	.30	.19		161.86
13.00	.28	.18		157.04
13.25				152.02
13.50				146.82
13.75				141.47
14.00				135.99
14.25				130.39
14.50				124.68
14.75				118.89
15.00				113.03
15.25				107.11
15.50				101.15
15.75				95.15
16.00				89.11
16.25				83.05
16.50				76.97
16.75				70.88
17.00				64.80
17.25				58.72
17.50				52.67
17.75				46.65
18.00				40.69
18.25				34.87
18.50				29.14
18.75				23.74
19.00				18.88
19.25				15.27
19.50				13.11
19.75				11.59
20.00				10.39
20.25				9.34
20.50				8.49
20.75				7.77
21.00				7.05
21.25				6.45
21.50				5.91
21.75				5.44
22.00				5.02
22.25				4.64
22.50				4.31
22.75				4.01
23.00				3.74
23.25				3.50
23.50				3.29
23.75				3.11
24.00				2.96
24.25				2.83
24.50				2.71
24.75				2.61
25.00				2.56
25.25				2.51
25.50				2.45

Curvature around peak = -75.434

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 20 - Rural

Area (Sq.Km.)	87.22
Data interval (Hr)	.25
Design duration (Hr)	15.25
Total rain (mm)	114.90
Percentage runoff	63.44
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 5.8

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.25	.16	.00	3.26
.25	.26	.17	1.63	3.29
.50	.27	.17	3.27	3.33
.75	.28	.18	4.90	3.40
1.00	.29	.18	6.54	3.50
1.25	.30	.19	8.17	3.62
1.50	.32	.21	9.81	3.77
1.75	.35	.22	11.44	3.95
2.00	.36	.23	13.08	4.16
2.25	.38	.24	14.71	4.41
2.50	.40	.25	16.35	4.69
2.75	.42	.26	17.98	5.00
3.00	.44	.28	19.62	5.35
3.25	.47	.30	21.25	5.74
3.50	.49	.31	22.89	6.19
3.75	.53	.33	24.52	6.68
4.00	.56	.36	26.16	7.19
4.25	.60	.38	27.79	7.76
4.50	.73	.46	29.43	8.39
4.75	.87	.55	31.06	9.08
5.00	.95	.60	32.70	9.86
5.25	1.04	.66	34.33	10.72
5.50	1.16	.74	35.97	11.67
5.75	1.32	.83	37.60	12.73
6.00	1.61	1.02	37.08	13.88
6.25	2.00	1.27	36.01	15.14
6.50	2.66	1.69	34.94	16.54
6.75	3.63	2.30	33.87	18.17
7.00	6.22	3.94	32.80	20.09
7.25	13.36	8.47	31.73	22.41
7.50	29.82	18.92	30.66	25.95
7.75	13.36	8.47	29.60	32.15
8.00	6.22	3.94	28.53	39.55
8.25	3.63	2.30	27.46	47.47
8.50	2.66	1.69	26.39	55.56
8.75	2.00	1.27	25.32	63.67
9.00	1.61	1.02	24.25	72.31
9.25	1.32	.83	23.18	80.82
9.50	1.16	.74	22.12	89.35
9.75	1.04	.66	21.05	97.94
10.00	.95	.60	19.98	106.54

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10.25	.87	.55	18.91	115.15
10.50	.73	.4c	17.84	123.7[illegible]
10.75	.60	.3c	16.77	132.2[illegible]
11.00	.56	.3c	15.70	140.6[illegible]
11.25	.53	.33	14.64	148.97
11.50	.49	.31	13.57	157.17
11.75	.47	.3J	12.50	165.22
12.00	.44	.2c	11.43	173.0[illegible]
12.25	.42	.2c	10.3c	180.6[illegible]
12.50	.40	.25	9.29	187.9[illegible]
12.75	.38	.24	8.22	194.7[illegible]
13.00	.36	.23	7.16	200.7[illegible]
13.25	.35	.22	6.09	204.94
13.50	.32	.21	5.02	205.2[illegible]
13.75	.30	.1y	[illegible].9[illegible]	203.0[illegible]
14.00	.29	.1[illegible]	2.8[illegible]	199.7[illegible]
14.25	.28	.1c	1.81	195.[illegible]
14.50	.27	.17	.74	191.5[illegible]
14.75	.26	.17		186.9[illegible]
15.00	.25	.1c		182.1[illegible]
15.25				177.21
15.50				172.0[illegible]
15.75				166.82
16.00				161.42
16.25				155.91
16.50				150.3[illegible]
16.75				144.6[illegible]
17.00				138.8[illegible]
17.25				133.0[illegible]
17.50				127.24
17.75				121.34
18.00				115.41
18.25				109.44
18.50				103.44
18.75				97.41
19.00				91.3[illegible]
19.25				85.3[illegible]
19.50				79.24
19.75				73.1[illegible]
20.00				67.14
20.25				61.1[illegible]
20.50				55.1[illegible]
20.75				49.1[illegible]
21.00				43.2[illegible]
21.25				37.5[illegible]
21.50				31.95
21.75				26.62
22.00				21.7[illegible]
22.25				18.0[illegible]
22.50				15.77
22.75				14.1[illegible]
23.00				12.8[illegible]
23.25				11.7[illegible]
23.50				10.8[illegible]
23.75				9.9[illegible]
24.00				9.2[illegible]
24.25				8.5[illegible]
24.50				7.9[illegible]
24.75				7.4[illegible]
25.00				6.9[illegible]
25.25				6.4[illegible]
25.50				6.0[illegible]
25.75				5.7[illegible]
26.00				5.3[illegible]
26.25				5.0[illegible]
26.50				4.8[illegible]
26.75				4.5[illegible]
27.00				4.34
27.25				4.14
27.50				3.9[illegible]
27.75				3.8[illegible]
28.00				3.6[illegible]
28.25				3.57
28.50				3.47
28.75				3.4[illegible]
29.00				3.34
29.25				3.3[illegible]
29.50				3.27

[illegible] around [illegible] = -75.4[illegible]

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 3A - Rural

Area (Sq.Km.)	6.00
Data interval (Hr)	.25
Design duration (Hr)	6.25
Total rain (mm)	108.26
Percentage runoff	62.77
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 2.4

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.63	.40	.00	.22
.25	.77	.48	9.55	.25
.50	.83	.52	19.10	.39
.75	.91	.57	28.65	.35
1.00	1.02	.64	38.19	.49
1.25	1.14	.72	47.74	.64
1.50	1.42	.89	57.29	.83
1.75	1.78	1.12	66.84	1.07
2.00	2.40	1.50	76.39	1.38
2.25	3.32	2.08	85.94	1.77
2.50	5.99	3.76	89.17	2.27
2.75	14.12	8.87	82.93	2.94
3.00	39.62	24.87	76.69	4.07
3.25	14.12	8.87	70.45	6.57
3.50	5.99	3.76	64.21	9.53
3.75	3.32	2.08	57.97	12.64
4.00	2.40	1.50	51.72	15.79
4.25	1.78	1.12	45.48	18.94
4.50	1.42	.89	39.24	22.07
4.75	1.14	.72	33.00	25.05
5.00	1.02	.64	26.76	27.76
5.25	.91	.57	20.52	30.00
5.50	.83	.52	14.28	30.83
5.75	.77	.48	8.04	29.94
6.00	.63	.40	1.80	26.43
6.25				26.67
6.50				24.74
6.75				22.77
7.00				20.59
7.25				18.47
7.50				16.27
7.75				13.99
8.00				11.75
8.25				9.51
8.50				7.29
8.75				5.19
9.00				3.35
9.25				2.28
9.50				1.71
9.75				1.33
10.00				1.05
10.25				.84
10.50				.67
10.75				.57
11.00				.47
11.25				.39
11.50				.29
11.75				.29
12.00				.23

Curvature around peak = -27.514

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 3b - Rural

Area (Sq.Km.)	10.64
Data interval (Hr)	.25
Design duration (Hr)	7.75
Total rain (mm.)	110.29
Percentage runoff	62.98
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 3.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.46	.29	.00	.40
.25	.49	.31	6.11	.42
.50	.52	.33	12.22	.46
.75	.64	.41	18.33	.57
1.00	.78	.49	24.44	.68
1.25	.85	.53	30.56	.72
1.50	.93	.59	36.67	.87
1.75	1.04	.65	42.78	1.07
2.00	1.17	.74	48.89	1.30
2.25	1.45	.91	55.00	1.58
2.50	1.81	1.14	61.11	1.92
2.75	2.44	1.54	67.22	2.34
3.00	3.37	2.12	73.33	2.85
3.25	6.04	3.81	69.34	3.49
3.50	14.06	8.87	65.34	4.31
3.75	38.14	24.02	61.35	5.69
4.00	14.08	8.87	57.36	8.58
4.25	6.04	3.81	53.36	12.00
4.50	3.37	2.12	49.37	15.61
4.75	2.44	1.54	45.37	19.39
5.00	1.81	1.14	41.38	23.01
5.25	1.45	.91	37.39	26.72
5.50	1.17	.74	33.39	30.39
5.75	1.04	.65	29.40	33.99
6.00	.93	.59	25.40	37.46
6.25	.85	.53	21.41	40.74
6.50	.78	.49	17.41	43.65
6.75	.64	.41	13.42	45.64
7.00	.52	.33	9.43	45.07
7.25	.49	.31	5.43	43.57
7.50	.46	.29	1.44	41.65
7.75				39.59
8.00				37.34
8.25				34.99
8.50				32.55
8.75				30.06
9.00				27.51
9.25				24.93
9.50				22.32
9.75				19.68
10.00				17.04

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10.25	14.41
10.50	11.80
10.75	9.74
11.00	8.12
11.25	6.76
11.50	5.57
11.75	4.64
12.00	3.96
12.25	3.39
12.50	2.90
12.75	2.49
13.00	2.15
13.25	1.89
13.50	1.65
13.75	1.45
14.00	1.26
14.25	1.10
14.50	.96
14.75	.82
15.00	.70

Curvature around peak = -40.897

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 3C - Rural

Area (Sq.km.)	12.68
Data interval (Hr)	.25
Design duration (Hr)	8.25
Total rain (mm)	110.85
Percentage runoff	63.03
Base flow (cumecs per sq.km)	.037
CWI at start of storm	138.40

Triangular unit hydrograph computed from Tp= 3.2

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.44	.27	.00	.47
.25	.46	.29	5.37	.49
.50	.49	.31	10.74	.53
.75	.53	.33	16.11	.56
1.00	.65	.41	21.48	.67
1.25	.76	.49	26.86	.78
1.50	.85	.54	32.23	.93
1.75	.94	.59	37.60	1.11
2.00	1.04	.66	42.97	1.37
2.25	1.16	.74	48.34	1.60
2.50	1.46	.92	53.71	1.91
2.75	1.82	1.15	59.08	2.29
3.00	2.45	1.55	64.45	2.75
3.25	3.39	2.14	68.05	3.38
3.50	6.06	3.82	64.54	3.97
3.75	14.06	8.86	61.03	4.87
4.00	37.62	23.71	57.52	6.34
4.25	14.06	8.86	54.01	9.38
4.50	6.06	3.82	50.50	12.95
4.75	3.39	2.14	46.98	16.78
5.00	2.45	1.55	43.47	20.66
5.25	1.82	1.15	39.96	24.58
5.50	1.46	.92	36.45	28.51
5.75	1.18	.74	32.94	32.40
6.00	1.04	.66	29.43	36.25
6.25	.94	.59	25.92	39.99
6.50	.85	.54	22.41	43.59
6.75	.78	.49	18.90	46.99
7.00	.65	.41	15.39	49.80
7.25	.53	.33	11.88	51.34
7.50	.49	.31	8.37	50.57
7.75	.46	.29	4.86	46.94
8.00	.44	.27	1.35	40.93
8.25				44.72
8.50				42.36
8.75				39.89
9.00				37.34
9.25				34.72
9.50				32.04
9.75				29.33
10.00				26.55

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10.25	23.60
10.50	21.03
10.75	18.23
11.00	15.46
11.25	12.71
11.50	10.03
11.75	7.48
12.00	5.25
12.25	3.87
12.50	3.07
12.75	2.51
13.00	2.10
13.25	1.78
13.50	1.51
13.75	1.29
14.00	1.10
14.25	.94
14.50	.82
14.75	.71
15.00	.63
15.25	.57
15.50	.53
15.75	.50
16.00	.48

Curvature around peak = -37.016

Nigerian Capital City - Phase 1 - 25 Year Flood Estimate

Catchment 3D - Rural

Area (Sq.Km.)	19.60
Data interval (Hr)	.25
Design duration (Hr)	11.75
Total rain (mm)	115.08
Percentage runoff	63.46
Base flow (cusecs per sq.km)	.037
Cwi at start of storm	138.40

Triangular unit hydrograph computed from Tp= 4.4

Convolution of unit hycrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.32	.20	.00	.73
.25	.33	.21	2.84	.74
.50	.34	.22	5.66	.77
.75	.36	.23	8.52	.80
1.00	.38	.24	11.38	.85
1.25	.40	.25	14.20	.91
1.50	.42	.27	17.05	.99
1.75	.44	.28	19.89	1.08
2.00	.47	.30	22.73	1.18
2.25	.50	.32	25.57	1.30
2.50	.54	.34	28.41	1.44
2.75	.66	.42	31.25	1.60
3.00	.80	.51	34.09	1.79
3.25	.87	.55	36.93	2.00
3.50	.96	.61	39.77	2.24
3.75	1.06	.68	42.61	2.52
4.00	1.20	.76	45.45	2.83
4.25	1.49	.94	48.30	3.18
4.50	1.86	1.19	49.26	3.58
4.75	2.49	1.58	47.40	4.03
5.00	3.44	2.18	45.54	4.55
5.25	6.11	3.87	43.69	5.17
5.50	13.99	8.86	41.83	5.98
5.75	36.20	22.97	39.97	7.26
6.00	13.99	8.86	38.12	9.60
6.25	6.11	3.87	36.26	12.89
6.50	3.44	2.18	34.40	16.00
6.75	2.49	1.58	32.55	19.29
7.00	1.86	1.18	30.69	22.64
7.25	1.49	.94	28.83	26.02
7.50	1.20	.76	26.98	29.41
7.75	1.06	.68	25.12	32.79
8.00	.96	.61	23.26	36.16
8.25	.87	.55	21.41	39.51
8.50	.80	.51	19.55	42.81
8.75	.66	.42	17.69	46.07
9.00	.54	.34	15.83	49.24
9.25	.50	.32	13.98	52.35
9.50	.47	.30	12.12	55.25
9.75	.44	.28	10.26	57.97
10.00	.42	.27	8.41	60.13

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10.25	.40	.25	6.55	60.97
10.50	.38	.24	4.69	60.27
10.75	.36	.23	2.84	58.87
11.00	.34	.22	.98	57.23
11.25	.33	.21		55.42
11.50	.32	.20		53.5[illegible]
11.75				51.5[illegible]
12.00				49.4[illegible]
12.25				47.3[illegible]
12.50				45.1[illegible]
12.75				42.9[illegible]
13.00				40.64
13.25				38.34
13.50				36.02
13.75				33.6[illegible]
14.00				31.3[illegible]
14.25				28.9[illegible]
14.50				26.5[illegible]
14.75				24.2[illegible]
15.00				21.8[illegible]
15.25				19.4[illegible]
15.50				17.1[illegible]
15.75				14.77
16.00				12.4[illegible]
16.25				10.2[illegible]
16.50				8.0[illegible]
16.75				6.1[illegible]
17.00				4.7[illegible]
17.25				4.04
17.50				3.5[illegible]
17.75				3.1[illegible]
18.00				2.77
18.25				2.4[illegible]
18.50				2.2[illegible]
18.75				2.0[illegible]
19.00				1.8[illegible]
19.25				1.64
19.50				1.4[illegible]
19.75				1.3[illegible]
20.00				1.2[illegible]
20.25				1.1[illegible]
20.50				1.0[illegible]
20.75				.9[illegible]
21.00				.9[illegible]
21.25				.8[illegible]
21.50				.8[illegible]
21.75				.7[illegible]
22.00				.77
22.25				.7[illegible]
22.50				.74

Curvature around peak = -25.31[illegible]

APPENDIX D

100 year return period rural catchment floods

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1A - Rural

Area (Sq.Km.)	2.32
Data interval (Hr)	.25
Design duration (Hr)	2.25
Total rain (mm)	111.16
Percentage runoff	63.64
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= .8

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	2.81	1.79	.00	.05
.25	3.90	2.48	65.94	.45
.50	7.09	4.51	171.88	1.30
.75	16.95	10.79	257.81	3.05
1.00	49.67	31.61	230.07	6.48
1.25	16.95	10.79	173.90	15.44
1.50	7.09	4.51	117.73	25.19
1.75	3.90	2.48	61.56	32.71
2.00	2.81	1.79	5.39	31.67
2.25				26.26
2.50				19.27
2.75				11.90
3.00				5.21
3.25				2.27
3.50				.99
3.75				.35
4.00				.11

Curvature around peak = -136.867

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1B - Rural

Area (Sq.Km.)	7.41
Data interval (Hr)	.25
Design duration (Hr)	6.25
Total rain (mm)	129.36
Percentage runoff	65.46
Base flow (cumecs per sq.km)	.036
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 2.4

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.76	.50	.00	.29
.25	.92	.60	9.55	.32
.50	1.00	.66	19.10	.40
.75	1.10	.72	28.65	.52
1.00	1.23	.80	38.19	.70
1.25	1.36	.90	47.74	.93
1.50	1.71	1.12	57.29	1.23
1.75	2.14	1.40	66.84	1.60
2.00	2.89	1.89	76.39	2.05
2.25	4.00	2.62	85.94	2.65
2.50	7.20	4.71	89.17	3.46
2.75	16.91	11.07	82.93	4.50
3.00	46.87	30.66	76.69	6.25
3.25	16.91	11.07	70.45	10.09
3.50	7.20	4.71	64.21	14.67
3.75	4.00	2.62	57.97	19.45
4.00	2.89	1.89	51.72	24.24
4.25	2.14	1.40	45.48	29.07
4.50	1.71	1.12	39.24	33.81
4.75	1.36	.90	33.00	38.39
5.00	1.23	.80	26.76	42.69
5.25	1.10	.72	20.52	46.04
5.50	1.00	.66	14.28	47.31
5.75	.92	.60	8.04	45.96
6.00	.76	.50	1.80	43.65
6.25				40.94
6.50				37.99
6.75				34.66
7.00				31.62
7.25				28.29
7.50				24.99
7.75				21.47
8.00				18.02
8.25				14.58
8.50				11.18
8.75				7.94
9.00				5.13
9.25				3.47
9.50				2.58
9.75				2.00
10.00				1.57
10.25				1.27
10.50				.97
10.75				.76
11.00				.60
11.25				.47
11.50				.35
11.75				.32
12.00				.29

Curvature around peak = -42.005

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1C - Rural

Area (Sq.Km.)	12.39
Data interval (Hr)	.25
Design duration (Hr)	8.75
Total rain (mm)	133.89
Percentage runoff	65.91
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 3.4

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.49	.36	.00	.47
.25	.52	.34	4.76	.49
.50	.55	.36	9.52	.57
.75	.59	.39	14.27	.59
1.00	.63	.42	19.03	.69
1.25	.76	.51	23.79	.79
1.50	.94	.66	28.55	.92
1.75	1.02	.67	33.30	1.19
2.00	1.12	.74	38.06	1.31
2.25	1.25	.82	42.82	1.57
2.50	1.41	.93	47.58	1.69
2.75	1.74	1.15	52.34	2.24
3.00	2.18	1.44	57.09	2.67
3.25	2.94	1.94	61.85	3.19
3.50	4.06	2.68	63.46	3.69
3.75	7.26	4.79	60.35	4.54
4.00	16.86	11.11	57.24	5.57
4.25	45.17	29.77	54.13	7.14
4.50	16.86	11.11	51.02	10.46
4.75	7.26	4.79	47.91	14.49
5.00	4.06	2.68	44.80	18.56
5.25	2.94	1.94	41.69	22.82
5.50	2.18	1.44	38.58	27.12
5.75	1.74	1.15	35.48	31.49
6.00	1.41	.93	32.37	35.73
6.25	1.25	.82	29.26	39.99
6.50	1.12	.74	26.15	44.16
6.75	1.02	.67	23.04	48.22
7.00	.94	.66	19.93	52.10
7.25	.76	.51	16.82	55.69
7.50	.63	.42	13.71	58.57
7.75	.59	.39	10.60	59.69
8.00	.55	.36	7.49	58.63
8.25	.52	.34	4.38	56.79
8.50	.49	.32	1.27	54.55
8.75				52.12
9.00				49.54
9.25				46.84
9.50				44.05
9.75				41.19
10.00				38.27

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10.25	35.30
10.50	32.30
10.75	29.27
11.00	26.22
11.25	23.16
11.50	20.11
11.75	17.08
12.00	14.08
12.25	11.15
12.50	8.37
12.75	5.92
13.00	4.37
13.25	3.44
13.50	2.87
13.75	2.41
14.00	2.05
14.25	1.74
14.50	1.49
14.75	1.27
15.00	1.09
15.25	.94
15.50	.82
15.75	.71
16.00	.64
16.25	.57
16.50	.53
16.75	.50
17.00	.48

Curvature around peak = -34.425

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1D - Rural

Area (Sq.Km.)	16.42
Data interval (Hr)	.25
Design duration (Hr)	10.75
Total rain (mm)	136.76
Percentage runoff	66.20
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 4.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.41	.27	.00	.67
.25	.43	.28	2.44	.64
.50	.45	.30	6.86	.68
.75	.47	.31	10.31	.72
1.00	.50	.33	13.75	.79
1.25	.53	.35	17.19	.87
1.50	.56	.37	20.62	.95
1.75	.60	.40	24.06	1.10
2.00	.64	.43	27.50	1.25
2.25	.79	.52	30.94	1.42
2.50	.95	.63	34.38	1.62
2.75	1.03	.66	37.81	1.86
3.00	1.14	.75	41.25	2.17
3.25	1.27	.84	44.69	2.45
3.50	1.43	.95	48.12	2.82
3.75	1.77	1.17	51.56	3.27
4.00	2.21	1.46	55.00	3.77
4.25	2.97	1.96	52.75	4.26
4.50	4.10	2.71	50.51	4.89
4.75	7.30	4.83	48.26	5.64
5.00	16.81	11.13	46.01	6.69
5.25	44.11	29.20	43.77	8.22
5.50	16.81	11.13	41.52	11.43
5.75	7.30	4.83	39.27	15.27
6.00	4.10	2.71	37.03	19.27
6.25	2.97	1.96	34.78	23.43
6.50	2.21	1.46	32.53	27.69
6.75	1.77	1.17	30.29	31.86
7.00	1.43	.95	28.04	36.10
7.25	1.27	.84	25.79	40.32
7.50	1.14	.75	23.55	44.51
7.75	1.03	.68	21.30	48.68
8.00	.95	.63	19.05	52.73
8.25	.79	.52	16.81	56.70
8.50	.64	.43	14.56	60.52
8.75	.60	.40	12.31	64.11
9.00	.56	.37	10.07	67.27
9.25	.53	.35	7.82	69.42
9.50	.50	.33	5.57	68.65
9.75	.47	.31	3.33	67.27
10.00	.45	.30	1.08	65.26

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10.25	.43	.26	63.01
10.50	.41	.27	60.61
10.75			58.09
11.00			55.49
11.25			52.80
11.50			50.04
11.75			47.23
12.00			44.37
12.25			41.47
12.50			38.53
12.75			35.58
13.00			32.61
13.25			29.64
13.50			26.66
13.75			23.69
14.00			20.72
14.25			17.78
14.50			14.87
14.75			12.03
15.00			9.32
15.25			6.92
15.50			5.27
15.75			4.35
16.00			3.72
16.25			3.23
16.50			2.83
16.75			2.48
17.00			2.19
17.25			1.93
17.50			1.71
17.75			1.52
18.00			1.35
18.25			1.21
18.50			1.09
18.75			.98
19.00			.90
19.25			.83
19.50			.76
19.75			.71
20.00			.67
20.25			.65
20.50			.63

Curvature around peak = -43.268

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 1E - Rural

Area (Sq.Km.)	103.64
Data interval (Hr)	.25
Design duration (Hr)	15.25
Total rain (mm)	137.04
Percentage runoff	66.22
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 5.8

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.31	.20	.00	3.97
.25	.32	.21	1.63	4.00
.50	.33	.22	3.27	4.07
.75	.34	.23	4.90	4.18
1.00	.35	.23	6.54	4.32
1.25	.37	.24	8.17	4.51
1.50	.39	.26	9.81	4.73
1.75	.42	.28	11.44	5.00
2.00	.44	.29	13.08	5.32
2.25	.46	.30	14.71	5.69
2.50	.48	.32	16.35	6.11
2.75	.51	.34	17.98	6.56
3.00	.53	.35	19.62	7.11
3.25	.56	.37	21.25	7.70
3.50	.60	.40	22.89	8.35
3.75	.64	.42	24.52	9.07
4.00	.68	.45	26.16	9.84
4.25	.73	.49	27.79	10.73
4.50	.88	.58	29.43	11.69
4.75	1.05	.69	31.06	12.77
5.00	1.15	.76	32.70	13.98
5.25	1.26	.84	34.33	15.19
5.50	1.41	.93	35.97	16.63
5.75	1.59	1.06	37.60	18.22
6.00	1.95	1.29	37.08	19.95
6.25	2.42	1.61	36.01	21.84
6.50	3.21	2.12	34.94	23.94
6.75	4.38	2.90	33.87	26.34
7.00	7.45	4.93	32.80	29.17
7.25	15.90	10.53	31.73	32.78
7.50	34.78	23.04	30.66	36.06
7.75	15.90	10.53	29.60	47.19
8.00	7.45	4.93	28.53	56.07
8.25	4.38	2.90	27.46	65.62
8.50	3.21	2.12	26.39	81.60
8.75	2.42	1.61	25.32	93.56
9.00	1.95	1.29	24.25	106.29
9.25	1.59	1.06	23.18	118.63
9.50	1.41	.93	22.12	131.45
9.75	1.26	.84	21.05	144.10
10.00	1.15	.76	19.98	156.79

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10.25	1.05	.69	18.91	169.44
10.50	.88	.58	17.84	182.07
10.75	.73	.49	16.77	194.60
11.00	.68	.45	15.70	207.01
11.25	.64	.42	14.64	219.27
11.50	.60	.40	13.57	231.34
11.75	.56	.37	12.50	243.19
12.00	.53	.35	11.43	254.76
12.25	.51	.34	10.36	265.95
12.50	.48	.32	9.29	276.63
12.75	.46	.30	8.22	286.60
13.00	.44	.29	7.16	295.35
13.25	.42	.28	6.09	301.51
13.50	.39	.26	5.02	301.97
13.75	.37	.24	3.95	298.82
14.00	.35	.23	2.88	294.01
14.25	.34	.23	1.81	286.32
14.50	.33	.22	.74	282.03
14.75	.32	.21		275.30
15.00	.31	.20		266.25
15.25				260.95
15.50				253.41
15.75				245.65
16.00				237.70
16.25				229.58
16.50				221.32
16.75				212.95
17.00				204.49
17.25				195.93
17.50				187.30
17.75				178.60
18.00				169.85
18.25				161.07
18.50				152.19
18.75				143.25
19.00				134.34
19.25				125.41
19.50				116.46
19.75				107.51
20.00				96.59
20.25				89.70
20.50				80.86
20.75				72.08
21.00				63.40
21.25				54.90
21.50				46.66
21.75				38.81
22.00				31.70
22.25				26.17
22.50				22.78
22.75				20.36
23.00				18.42
23.25				16.78
23.50				15.35
23.75				14.09
24.00				12.97
24.25				11.96
24.50				11.05
24.75				10.22
25.00				9.45
25.25				8.82
25.50				8.21
25.75				7.66
26.00				7.14
26.25				6.70
26.50				6.29
26.75				5.92
27.00				5.58
27.25				5.28
27.50				5.02
27.75				4.79
28.00				4.59
28.25				4.42
28.50				4.28
28.75				4.17
29.00				4.08
29.25				4.02
29.50				3.99

Curvature around pad = -57.217

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 2A - Rural

Area (Sq.Km.)	57.85
Data interval (Hr)	.25
Design duration (Hr)	9.25
Total rain (mm)	130.24
Percentage runoff	65.54
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 3.5

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.51	.33	.00	2.21
.25	.54	.35	4.49	2.35
.50	.57	.37	8.98	2.49
.75	.61	.40	13.47	2.76
1.00	.65	.43	17.96	3.14
1.25	.70	.46	22.45	3.63
1.50	.85	.56	26.94	4.24
1.75	1.01	.66	31.43	4.99
2.00	1.10	.72	35.92	5.92
2.25	1.22	.80	40.41	7.02
2.50	1.36	.89	44.90	8.35
2.75	1.53	1.01	49.39	9.91
3.00	1.89	1.24	53.86	11.72
3.25	2.35	1.54	58.37	13.85
3.50	3.13	2.05	62.86	16.39
3.75	4.29	2.81	59.92	19.31
4.00	7.43	4.87	56.99	22.81
4.25	16.33	10.70	54.05	27.42
4.50	38.11	24.98	51.12	34.62
4.75	16.33	10.70	48.18	48.15
5.00	7.43	4.87	45.25	64.25
5.25	4.29	2.81	42.32	81.38
5.50	3.13	2.05	39.38	96.95
5.75	2.35	1.54	36.45	116.75
6.00	1.89	1.24	33.51	134.60
6.25	1.53	1.01	30.58	152.39
6.50	1.36	.89	27.64	170.01
6.75	1.22	.80	24.71	187.32
7.00	1.10	.72	21.77	204.19
7.25	1.01	.66	18.84	220.37
7.50	.85	.56	15.91	235.50
7.75	.70	.46	12.97	248.70
8.00	.65	.43	10.04	257.41
8.25	.61	.40	7.10	255.51
8.50	.57	.37	4.17	249.11
8.75	.54	.35	1.23	240.72
9.00	.51	.33		231.25
9.25				221.04
9.50				210.27
9.75				198.96
10.00				187.32

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10.25	175.3[illegible]
10.50	163.1[illegible]
10.75	150.7[illegible]
11.00	138.2[illegible]
11.25	125.5[illegible]
11.50	112.8[illegible]
11.75	100.07
12.00	87.34
12.25	74.6[illegible]
12.50	62.2[illegible]
12.75	49.9[illegible]
13.00	38.4[illegible]
13.25	28.33
13.50	21.4[illegible]
13.75	17.3[illegible]
14.00	14.5[illegible]
14.25	12.3[illegible]
14.50	10.5[illegible]
14.75	9.01
15.00	7.74
15.25	6.6[illegible]
15.50	5.7[illegible]
15.75	4.94
16.00	4.2[illegible]
16.25	3.74
16.50	3.31
16.75	2.9[illegible]
17.00	2.67
17.25	2.4[illegible]
17.50	2.3[illegible]
17.75	2.24

Curvature around peak = -169.867

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 2b - Rural

Area (Sq.km.)	64.45
Data interval (Hr)	.25
Design duration (Hr)	11.25
Total rain (mm)	133.42
Percentage runoff	65.86
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 4.2

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.42	.28	.00	2.47
.25	.44	.29	3.12	2.52
.50	.46	.31	6.24	2.64
.75	.49	.32	9.35	2.81
1.00	.51	.34	12.47	3.06
1.25	.54	.36	15.59	3.36
1.50	.58	.38	18.71	3.75
1.75	.61	.40	21.83	4.20
2.00	.66	.43	24.94	4.74
2.25	.71	.46	28.06	5.37
2.50	.85	.56	31.18	6.09
2.75	1.02	.67	34.30	6.93
3.00	1.11	.73	37.41	7.89
3.25	1.23	.81	40.53	9.00
3.50	1.37	.90	43.65	10.28
3.75	1.55	1.02	46.77	11.73
4.00	1.90	1.25	49.89	13.40
4.25	2.36	1.56	51.97	15.29
4.50	3.14	2.07	49.94	17.40
4.75	4.31	2.84	47.90	19.64
5.00	7.44	4.90	45.86	22.73
5.25	16.26	10.71	43.82	26.51
5.50	37.50	24.70	41.78	32.32
5.75	16.26	10.71	39.75	42.98
6.00	7.44	4.90	37.71	55.06
6.25	4.31	2.84	35.67	69.18
6.50	3.14	2.07	33.63	83.14
6.75	2.36	1.56	31.59	97.34
7.00	1.90	1.25	29.56	111.07
7.25	1.55	1.02	27.52	126.02
7.50	1.37	.90	25.48	140.32
7.75	1.23	.81	23.44	154.57
8.00	1.11	.73	21.41	168.60
8.25	1.02	.67	19.37	182.46
8.50	.85	.56	17.33	196.02
8.75	.71	.46	15.29	209.14
9.00	.66	.43	13.25	221.62
9.25	.61	.40	11.22	233.10
9.50	.58	.38	9.18	242.66
9.75	.54	.36	7.14	247.79
10.00	.51	.34	5.10	245.73

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10.25	.49	.32	3.06	240.56
10.50	.46	.31	1.03	233.96
10.75	.44	.29		226.56
11.00	.42	.28		218.59
11.25				210.22
11.50				201.50
11.75				192.49
12.00				183.23
12.25				173.75
12.50				164.09
12.75				154.27
13.00				144.32
13.25				134.30
13.50				124.21
13.75				114.07
14.00				103.92
14.25				93.76
14.50				83.61
14.75				73.51
15.00				63.49
15.25				53.61
15.50				43.98
15.75				34.86
16.00				26.76
16.25				20.97
16.50				17.52
16.75				15.10
17.00				13.19
17.25				11.59
17.50				10.24
17.75				9.07
18.00				8.05
18.25				7.16
18.50				6.38
18.75				5.70
19.00				5.11
19.25				4.60
19.50				4.16
19.75				3.78
20.00				3.45
20.25				3.15
20.50				2.90
20.75				2.77
21.00				2.64
21.25				2.54
21.50				2.49

Curvature around peak = -115.269

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 2C - Rural

Area (Sq.Km.)	66.17
Data interval (Hr)	.25
Design duration (Hr)	13.25
Total rain (mm)	136.26
Percentage runoff	66.15
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 5.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.34	.23	.00	2.53
.25	.35	.23	2.20	2.57
.50	.38	.25	4.40	2.67
.75	.41	.27	6.60	2.74
1.00	.43	.28	8.80	2.88
1.25	.44	.29	11.00	3.06
1.50	.47	.31	13.20	3.29
1.75	.49	.32	15.40	3.56
2.00	.52	.34	17.60	3.88
2.25	.55	.36	19.80	4.25
2.50	.58	.38	22.00	4.67
2.75	.62	.41	24.20	5.15
3.00	.66	.44	26.40	5.68
3.25	.71	.47	28.60	6.29
3.50	.85	.57	30.80	6.95
3.75	1.02	.68	33.00	7.77
4.00	1.11	.74	35.20	8.54
4.25	1.23	.81	37.40	9.50
4.50	1.37	.91	39.60	10.57
4.75	1.55	1.02	41.80	11.79
5.00	1.90	1.26	44.00	13.13
5.25	2.37	1.57	42.56	14.69
5.50	3.15	2.08	41.12	16.27
5.75	4.31	2.85	39.69	18.17
6.00	7.44	4.92	38.25	20.41
6.25	16.24	10.74	36.81	23.31
6.50	37.35	24.71	35.37	27.70
6.75	16.24	10.74	33.93	35.61
7.00	7.44	4.92	32.50	45.01
7.25	4.31	2.85	31.06	55.04
7.50	3.15	2.08	29.62	65.45
7.75	2.37	1.57	28.18	75.97
8.00	1.90	1.26	26.75	86.67
8.25	1.55	1.02	25.31	97.45
8.50	1.37	.91	23.87	108.24
8.75	1.23	.81	22.43	119.07
9.00	1.11	.74	20.99	129.84
9.25	1.02	.68	19.56	140.54
9.50	.85	.57	18.12	151.17
9.75	.71	.47	16.68	161.67
10.00	.66	.44	15.24	171.88

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10.25	.62	.41	13.80	181.9?
10.50	.58	.38	12.37	191.66
10.75	.55	.36	10.93	200.94
11.00	.52	.34	9.49	209.59
11.25	.49	.32	8.05	217.10
11.50	.47	.31	6.61	222.05
11.75	.44	.29	5.18	221.15
12.00	.43	.28	3.74	217.6?
12.25	.41	.27	2.30	213.07
12.50	.38	.25	.86	207.81
12.75	.35	.23		202.09
13.00	.34	.23		196.05
13.25				189.77
13.50				183.26
13.75				176.56
14.00				169.69
14.25				162.6?
14.50				155.5?
14.75				148.2?
15.00				140.94
15.25				133.54
15.50				126.0?
15.75				118.56
16.00				111.00
16.25				103.41
16.50				95.80
16.75				88.1?
17.00				80.5?
17.25				72.9?
17.50				65.3?
17.75				57.84
18.00				50.3?
18.25				43.04
18.50				35.92
18.75				29.15
19.00				23.08
19.25				18.55
19.50				15.??
19.75				13.64
20.00				12.4?
20.25				11.1?
20.50				10.0?
20.75				9.11
21.00				8.2?
21.25				7.5?
21.50				6.84
21.75				6.24
22.00				5.71
22.25				5.24
22.50				4.8?
22.75				4.45
23.00				4.1?
23.25				3.8?
23.50				3.5?
23.75				3.3?
24.00				3.1?
24.25				2.97
24.50				2.8?
24.75				2.7?
25.00				2.64
25.25				2.5?
25.50				2.55

Curvature around peak = -94.444

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 2b - Rural

Area (Sq.Km.)	67.22
Data interval (Hr)	.25
Design duration (Hr)	15.25
Total rain (mm)	137.70
Percentage runoff	66.29
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 5.6

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.30	.20	.00	3.34
.25	.31	.21	1.63	3.37
.50	.32	.22	3.27	3.43
.75	.34	.22	4.90	3.51
1.00	.35	.23	6.54	3.64
1.25	.36	.24	8.17	3.79
1.50	.39	.26	9.81	3.98
1.75	.42	.28	11.44	4.20
2.00	.43	.29	13.08	4.47
2.25	.45	.30	14.71	4.77
2.50	.48	.32	16.35	5.12
2.75	.50	.33	17.98	5.51
3.00	.53	.35	19.62	5.95
3.25	.56	.37	21.25	6.44
3.50	.59	.39	22.89	6.98
3.75	.63	.42	24.52	7.58
4.00	.67	.45	26.16	8.24
4.25	.72	.48	27.79	8.96
4.50	.87	.58	29.43	9.75
4.75	1.04	.69	31.06	10.63
5.00	1.13	.75	32.70	11.60
5.25	1.25	.83	34.33	12.69
5.50	1.39	.92	35.97	13.87
5.75	1.58	1.05	37.60	15.20
6.00	1.93	1.28	37.08	16.64
6.25	2.40	1.59	36.01	18.21
6.50	3.19	2.11	34.94	19.96
6.75	4.35	2.89	33.87	21.96
7.00	7.45	4.94	32.80	24.32
7.25	16.03	10.63	31.73	27.32
7.50	35.74	23.69	30.66	31.79
7.75	16.03	10.63	29.60	39.56
8.00	7.45	4.94	28.53	46.79
8.25	4.35	2.89	27.46	56.63
8.50	3.19	2.11	26.39	66.83
8.75	2.40	1.59	25.32	76.25
9.00	1.93	1.28	24.25	89.81
9.25	1.58	1.05	23.18	100.47
9.50	1.39	.92	22.12	111.19
9.75	1.25	.83	21.05	121.94
10.00	1.13	.75	19.98	132.70

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10.25	1.04	.69	18.91	143.47
10.50	.87	.58	17.84	154.19
10.75	.72	.48	16.77	164.85
11.00	.67	.45	15.70	175.40
11.25	.63	.42	14.64	185.81
11.50	.59	.39	13.57	196.08
11.75	.56	.37	12.50	206.16
12.00	.53	.35	11.43	216.00
12.25	.50	.33	10.36	225.53
12.50	.48	.32	9.29	234.64
12.75	.45	.30	8.22	243.15
13.00	.43	.29	7.16	250.63
13.25	.42	.28	6.09	255.91
13.50	.39	.26	5.02	256.27
13.75	.36	.24	3.95	253.54
14.00	.35	.23	2.88	249.41
14.25	.34	.22	1.81	244.53
14.50	.32	.26	.74	239.15
14.75	.31	.21		233.41
15.00	.30	.20		227.49
15.25				221.19
15.50				214.77
15.75				208.17
16.00				201.41
16.25				194.50
16.50				187.49
16.75				180.37
17.00				173.19
17.25				165.92
17.50				158.60
17.75				151.21
18.00				143.79
18.25				136.30
18.50				128.79
18.75				121.24
19.00				113.67
19.25				106.08
19.50				98.49
19.75				90.90
20.00				83.32
20.25				75.79
20.50				68.29
20.75				60.84
21.00				53.47
21.25				46.25
21.50				39.26
21.75				32.59
22.00				26.54
22.25				21.84
22.50				19.01
22.75				16.99
23.00				15.37
23.25				14.00
23.50				12.81
23.75				11.76
24.00				10.82
24.25				9.99
24.50				9.27
24.75				8.54
25.00				7.93
25.25				7.37
25.50				6.87
25.75				6.41
26.00				5.99
26.25				5.61
26.50				5.27
26.75				4.96
27.00				4.68
27.25				4.43
27.50				4.21
27.75				4.02
28.00				3.86
28.25				3.72
28.50				3.60
28.75				3.51
29.00				3.44
29.25				3.39
29.50				3.35

Curvature around pr.n. = -65.317

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 3A - Rural

Area (Sq.Km.)	6.00
Data interval (Hr)	.25
Design duration (Hr)	6.25
Total rain (mm)	129.75
Percentage runoff	65.50
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 2.4

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.76	.50	.00	.23
.25	.92	.60	9.55	.28
.50	1.00	.65	19.10	.32
.75	1.10	.72	28.65	.42
1.00	1.22	.80	38.19	.56
1.25	1.37	.90	47.74	.75
1.50	1.70	1.11	57.29	.99
1.75	2.13	1.39	66.84	1.29
2.00	2.87	1.88	76.39	1.67
2.25	3.98	2.60	85.94	2.10
2.50	7.18	4.70	89.17	2.78
2.75	16.93	11.09	82.93	3.62
3.00	47.48	31.10	76.69	5.04
3.25	16.93	11.09	70.45	8.17
3.50	7.18	4.70	64.21	11.66
3.75	3.98	2.60	57.97	15.75
4.00	2.87	1.88	51.72	19.69
4.25	2.13	1.39	45.48	23.63
4.50	1.70	1.11	39.24	27.49
4.75	1.37	.90	33.00	31.21
5.00	1.22	.80	26.76	34.66
5.25	1.10	.72	20.52	37.46
5.50	1.00	.65	14.28	38.50
5.75	.92	.60	8.04	37.39
6.00	.76	.50	1.80	35.50
6.25				33.29
6.50				30.68
6.75				28.34
7.00				25.77
7.25				22.99
7.50				20.23
7.75				17.44
8.00				14.64
8.25				11.84
8.50				9.07
8.75				6.43
9.00				4.14
9.25				2.79
9.50				2.09
9.75				1.61
10.00				1.26
10.25				.99
10.50				.79
10.75				.64
11.00				.49
11.25				.39
11.50				.31
11.75				.26
12.00				.24

Curvature around peak = -34.404

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 3b - Rural

Area (Sq.Km.)	10.64
Data interval (Hr)	.25
Design duration (Hr)	7.75
Total rain (mm)	132.18
Percentage runoff	65.74
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 3.0

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total hydrograph
.00	.55	.36	.00	.41
.25	.59	.39	6.11	.43
.50	.63	.41	12.22	.48
.75	.77	.51	18.33	.55
1.00	.93	.61	24.44	.66
1.25	1.02	.67	30.56	.81
1.50	1.12	.73	36.67	1.00
1.75	1.24	.82	42.78	1.24
2.00	1.40	.92	48.89	1.54
2.25	1.73	1.14	55.00	1.89
2.50	2.17	1.43	61.11	2.31
2.75	2.92	1.92	67.22	2.87
3.00	4.04	2.66	73.33	3.48
3.25	7.24	4.76	69.34	4.26
3.50	16.88	11.09	65.34	5.30
3.75	45.71	30.05	61.35	7.07
4.00	16.88	11.09	57.36	10.65
4.25	7.24	4.76	53.36	14.97
4.50	4.04	2.66	49.37	19.44
4.75	2.92	1.92	45.37	24.05
5.00	2.17	1.43	41.38	28.70
5.25	1.73	1.14	37.39	33.34
5.50	1.40	.92	33.39	37.93
5.75	1.24	.82	29.40	42.43
6.00	1.12	.73	25.40	46.77
6.25	1.02	.67	21.41	50.88
6.50	.93	.61	17.41	54.57
6.75	.77	.51	13.42	57.01
7.00	.63	.41	9.43	56.29
7.25	.59	.39	5.43	54.41
7.50	.55	.36	1.44	52.05
7.75				49.43
8.00				46.69
8.25				43.69
8.50				40.63
8.75				37.51
9.00				34.37
9.25				31.19
9.50				27.83
9.75				24.53
10.00				21.23

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10.25	17.9?
10.50	14.67
10.75	11.47
11.00	8.44
11.25	5.79
11.50	4.12
11.75	3.21
12.00	2.61
12.25	2.1?
12.50	1.7?
12.75	1.4?
13.00	1.2?
13.25	1.07
13.50	.??
13.75	.72
14.00	.61
14.25	.5?
14.50	.47
14.75	.4?
15.00	.41

Curvature around peak = -51.163

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 3C - Rural

Area (Sq.Km.)	12.66
Data interval (Hr)	.25
Design duration (Hr)	8.25
Total rain (mm)	132.85
Percentage runoff	65.81
Base flow (cumecs per sq.km)	.036
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 3.2

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.52	.34	.00	.49
.25	.55	.36	5.37	.51
.50	.59	.39	10.74	.56
.75	.63	.42	16.11	.63
1.00	.78	.51	21.48	.73
1.25	.94	.62	26.86	.87
1.50	1.02	.67	32.23	1.05
1.75	1.13	.74	37.60	1.28
2.00	1.25	.82	42.97	1.56
2.25	1.41	.93	48.34	1.89
2.50	1.75	1.15	53.71	2.28
2.75	2.19	1.44	59.08	2.76
3.00	2.94	1.93	64.45	3.37
3.25	4.06	2.67	69.05	4.07
3.50	7.26	4.78	64.54	4.84
3.75	16.85	11.09	61.03	5.99
4.00	45.09	29.67	57.52	7.82
4.25	16.85	11.09	54.01	11.63
4.50	7.26	4.78	50.50	16.13
4.75	4.06	2.67	46.98	20.68
5.00	2.94	1.93	43.47	25.74
5.25	2.19	1.44	39.96	30.65
5.50	1.75	1.15	36.45	35.56
5.75	1.41	.93	32.94	40.44
6.00	1.25	.82	29.43	45.24
6.25	1.13	.74	25.92	49.93
6.50	1.02	.67	22.41	54.43
6.75	.94	.62	18.90	58.64
7.00	.78	.51	15.39	62.20
7.25	.63	.42	11.88	64.17
7.50	.59	.39	8.37	63.17
7.75	.55	.36	4.86	61.12
8.00	.52	.34	1.35	58.61
8.25				55.85
8.50				52.90
8.75				49.80
9.00				46.61
9.25				43.32
9.50				39.95
9.75				36.59
10.00				33.19

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10.25	24.65
10.50	26.19
10.75	22.70
11.00	19.23
11.25	15.85
11.50	12.44
11.75	9.26
12.00	6.46
12.25	4.67
12.50	3.69
12.75	3.03
13.00	2.52
13.25	2.11
13.50	1.79
13.75	1.50
14.00	1.27
14.25	1.07
14.50	.91
14.75	.78
15.00	.65
15.25	.61
15.50	.55
15.75	.51
16.00	.40

Curvature around peak = -46.312

Nigerian Capital City - Phase 1 - 100 Year Flood Estimate

Catchment 30 - Rural

Area (Sq.Km.)	19.60
Data interval (hr)	.25
Design duration (Hr)	11.75
Total rain (mm)	137.92
Percentage runoff	66.31
Base flow (cumecs per sq.km)	.038
CWI at start of storm	141.00

Triangular unit hydrograph computed from Tp= 4.4

Convolution of unit hydrograph and net rain profile

Time	Total Rain mm	Net Rain mm	Unit Hydrograph ordinate	Total Hydrograph
.00	.38	.25	.00	.75
.25	.39	.26	2.84	.76
.50	.41	.27	5.68	.79
.75	.43	.29	8.52	.84
1.00	.45	.30	11.36	.90
1.25	.48	.32	14.20	.97
1.50	.50	.33	17.05	1.07
1.75	.53	.35	19.89	1.18
2.00	.57	.38	22.73	1.31
2.25	.60	.40	25.57	1.47
2.50	.65	.43	28.41	1.64
2.75	.79	.53	31.25	1.84
3.00	.96	.63	34.09	2.07
3.25	1.04	.69	36.93	2.33
3.50	1.15	.76	39.77	2.64
3.75	1.28	.85	42.61	2.98
4.00	1.44	.96	45.45	3.37
4.25	1.78	1.18	48.30	3.87
4.50	2.23	1.48	49.20	4.32
4.75	2.99	1.98	47.40	4.84
5.00	4.12	2.73	45.54	5.53
5.25	7.32	4.85	43.69	6.30
5.50	16.77	11.12	41.83	7.32
5.75	43.39	28.77	39.97	8.92
6.00	16.77	11.12	38.12	12.10
6.25	7.32	4.85	36.26	15.67
6.50	4.12	2.73	34.40	19.87
6.75	2.99	1.98	32.55	23.99
7.00	2.23	1.48	30.69	28.19
7.25	1.78	1.18	28.83	32.47
7.50	1.44	.96	26.98	36.66
7.75	1.28	.85	25.12	40.90
8.00	1.15	.76	23.26	45.12
8.25	1.04	.69	21.41	49.31
8.50	.96	.63	19.55	53.45
8.75	.79	.53	17.69	57.54
9.00	.65	.43	15.83	61.53
9.25	.60	.40	13.98	65.39
9.50	.57	.38	12.12	69.07
9.75	.53	.35	10.26	72.42
10.00	.50	.33	8.41	75.14

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10.25	.46	.32	6.55	76.19
10.50	.45	.30	4.69	75.27
10.75	.43	.29	2.84	73.56
11.00	.41	.27	.98	71.50
11.25	.39	.26		69.24
11.50	.38	.25		66.64
11.75				64.34
12.00				61.74
12.25				59.08
12.50				56.35
12.75				53.56
13.00				50.72
13.25				47.85
13.50				44.94
13.75				42.01
14.00				39.06
14.25				36.10
14.50				33.13
14.75				30.16
15.00				27.19
15.25				24.22
15.50				21.24
15.75				18.33
16.00				15.44
16.25				12.62
16.50				9.93
16.75				7.52
17.00				5.84
17.25				4.89
17.50				4.27
17.75				3.72
18.00				3.29
18.25				2.93
18.50				2.62
18.75				2.34
19.00				2.10
19.25				1.89
19.50				1.70
19.75				1.54
20.00				1.40
20.25				1.29
20.50				1.17
20.75				1.08
21.00				1.00
21.25				.93
21.50				.87
21.75				.83
22.00				.79
22.25				.77
22.50				.76

Curvature around peak = -31.702

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